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SELECTED WATER RESOURCES ABSTRACTS

VOLUME 12, NUMBER 19
OCTOBER 1, 1979

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SELECTED WATER RESOURCES ABSTRACTS

A Semimonthly Publication of the Water Resources Scientific Information Center, Office of Water Research and Technology, U.S. Department of the Interior

VOLUME 12, NUMBER 19
OCTOBER 1, 1979

W79- 08831 -- W79-09080

The Secretary of the U.S. Department of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through August 31, 1983.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

FOREWORD

Selected Water Resources Abstracts, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifiers which are listed in the **Water Resources Thesaurus.** Each abstract entry is classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

WRSIC IS NOT PRESENTLY IN A POSITION TO PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas.

Additional "centers of competence" have been established in cooperation with the Environmental Protection Agency. A directory of the Centers appears on the inside back cover.

Supplementary documentation is being secured from established discipline-oriented abstracting and indexing services. Currently an arrangement is in effect whereby the BioScience Information Service of Biological Abstracts supplies WRSIC with relevant references from the several subject areas of interest to our users. In addition to Biological Abstracts, references are acquired from Bioresearch Index which are without abstracts and therefore also appear abstractless in SWRA. Similar arrangements with other producers of abstracts are contemplated as planned augmentation of the information base.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Research and Technology and other Federal water resource agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangements of this bulletin are welcome.

Water Resources Scientific Information Center
Office of Water Research and Technology
U.S. Department of the Interior
Washington, DC 20240

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Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2D. Evaporation and Transpiration

RELEVANCE OF IFYGL,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 5C.
W79-08873

2E. Streamflow and Runoff

A MATHEMATICAL MODEL FOR UNSTEADY-FLOW COMPUTATIONS THROUGH THE COMPLETE SPECTRUM OF FLOWS ON THE LOWER OHIO RIVER,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
B. H. Johnson.
Available from the National Technical Information Service, Springfield, VA 22161 as AD-A047 242, Price codes: A03 in paper copy, A01 in microfiche. Technical Report No. H-77-18. Final Report, October 1977. Prepared for U.S. Army Engineer Division, Ohio River, Cincinnati, Ohio. 47 p, 8 fig, 3 tab, 8 ref, 2 append.

Descriptors: *Mathematical models, *Ohio River, *Flow control, *Dams, *Flow rates, Navigable rivers, Levees, Flood control, Flood forecasting, Locks, River flow, Hydrographs, Model studies, Synthetic hydrology.

A model, Simulation of Open Channel Hydraulics in Multi-Junction Systems (SOCHMJ), was calibrated and modified to simulate flow conditions of the Ohio River. The model can be applied to condition of low-flow as well as flooding. The water system studied is composed of portions of six rivers, the Ohio, Green, Wabash, Cumberland, Tennessee, and Mississippi Rivers. The system also involves five locks and dams on the Ohio River. Modifications were made to allow for the specification of two time steps, one for branches with spatial steps about five miles in length and the other for smaller branches with spatial steps about a mile or less in length. Results showed that the model is potentially useful to assist in regulating navigation dams on the Ohio River. Also flood control simulation is possible to safeguard the Mississippi River levee system, reduce the frequency of use of the Birds Point-New Madrid floodway, and to reduce the frequency and magnitude of flooding of lands not protected by levees. (Seigler-IPA)
W79-09064

2F. Groundwater

AQUIFER MODELING BY NUMERICAL METHODS APPLIED TO AN ARIZONA GROUNDWATER BASIN,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 6A.
W79-09052

2H. Lakes

ZOOBENTHOS OF LAKES,
Copenhagen Univ. (Denmark). Freshwater Biological Lab.
For primary bibliographic entry see Field 5C.
W79-08833

A MATHEMATICAL HYDRODYNAMIC CIRCULATION MODEL OF GREAT SALT LAKE FOR RESOURCE MANAGEMENT,
Utah Water Research Lab., Logan.
G. Z. Watters, and C. T. Kincaid.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 013, Price codes: A05 in paper copy, A01 in microfiche. Final Report, June 1979. 74 p, 27 fig, 14 tab. OWRT B-139-UTAH(6), 14-34-0001-7191.

Descriptors: Finite element method, Hydrodynamics, Circulation, Salts, Stratified flow, *Model studies, Mathematical models, *Great Salt Lake, Utah.

A hydrodynamic circulation model for Great Salt Lake was developed along with several supporting mathematical models required to provide information on boundary conditions and mixing processes. Two of the supporting models were developed to describe bidirectional (1) seepage flow, and (2) culvert flow through the railroad causeway which divides the lake into a north and south arm. A third model utilizes the velocity field computed by the circulation model and provides information on convective and dispersive processes in the lake. A laboratory study was directed toward establishing the diffuse transfer of material from the lower layer of the south arm to the upper layer. The mathematical models were converted to numerical models using the finite element method. Solutions were found using the Galerkin method of weighted residuals. The seepage flow analysis was used to develop curves of northward and southward flow through the railroad causeway fill for various lake surface elevations. The bidirectional culvert flow analysis was not similarly successful, and the analysis of earlier investigators was taken as adequate. Attempts at modeling circulation within the two water layers in the south arm with a three-dimensional free surface model were successful to a degree, but solution of the equations proved too costly with existing computer facilities. A two-dimensional, depth-averaged circulation model was completed to compute velocity fields in the upper layer of the south arm. The convection-dispersion model utilized the resulting velocity field and computed dispersion and decay of salinity and pollutants. The present model does not handle wind-driven circulation, but it appears to work for flow-through boundary conditions.
W79-09054

PRELIMINARY WATER-QUALITY EVALUATION OF A LOWER POOL ELEVATION FOR PROPOSED LAFARGE LAKE, WISCONSIN,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Effects Lab.
D. E. Ford, K. W. Thornton, and D. L. Robey.
Available from the National Technical Information Service, Springfield, VA 22161 as AD-A040 822, Price codes: A04 in paper copy, A01 in microfiche. Miscellaneous Paper No. Y-77-2. Final Report, May 1977. Prepared for U.S. Army Engineer District, St. Paul, Minnesota. 75 p, 33 fig, 5 ref.

Descriptors: *LaFarge Lake, *Water quality, *Mathematical models, *Eutrophication, *Computer models, *Elevation, Wisconsin, Phosphorus, Reservoirs, Algae, Diatoms, Dissolved oxygen, Turbidity, Coliforms, Vollenweider loading curves, Altitude, Nutrient requirements, Water temperature, Kickapoo River, Hypolimnion.

A modified version of the reservoir portion of the Water Quality for River-Reservoir Systems (WQRRS) ecological model was used to simulate the water quality of a proposed lake, LaFarge Lake, Wisconsin. The lake was previously modeled for a higher elevation of 256m., and results from this study are used for comparisons. This simulation was for a lower elevation of 250.5m. Areas studied were water temperature, dissolved oxygen content, and algal growth. Results show that at the lower elevation temperature stratification was weak and intermittent. The distribution of dissolved oxygen was good during periods of complete mixing, but was rapidly depleted on the lake bottom during periods of stratification. Two major blooms of blue-green algae were predicted during the summer and fall. During the spring, a bloom of green algae and diatoms was predicted. At the lower elevation of 250.5m, the magnitude of the blue-green algae bloom increased, and coliform persisted longer. Also at the lower elevation, the phosphorus loadings were approximately twice as large, but due to an increased flushing rate at that level, the eutrophication potentials were similiar at both elevations. (Seigler-IPA)
W79-09065

2J. Erosion and Sedimentation

PALEOLIMNOLOGIC EVIDENCE FOR INCREASED ZINC LOADING IN LAKES OF NEW ENGLAND, U.S.A.,
Maine Univ. at Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5C.
W79-08909

CORRELATION BETWEEN EXCHANGEABLE PHOSPHORUS AND SEDIMENTARY PIGMENT IN SOME IRISH LAKES,
Dundalk Regional Technical College, County Louth (Ireland). Science Dept.
For primary bibliographic entry see Field 5C.
W79-08922

2L. Estuaries

NUTRIENT KINETICS OF PHYTOPLANKTON IN THE PAMLICO RIVER, NORTH CAROLINA,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
E. J. Kuenzler, D. W. Stanley, and J. P. Koenings.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 063, Price codes: A09 in paper copy, A01 in microfiche. Water Resources Research Institute of The University of North Carolina, Raleigh. UNC-WRRI Rpt. No. 139, May 1979. 163 p, 49 fig, 40 tab. OWRT B-092-NC(1), 14-34-0001-6105.

Descriptors: *Nutrients, *Phytoplankton, Nitrogen, Phosphorus, Sampling, *Pamlico River(NC).

A field study of physical conditions, nutrient concentrations, and phytoplankton abundance in the Pamlico River estuary was conducted in conjunction with laboratory measurements of rates of photosynthesis and uptake of nitrate, ammonium, and phosphate under ambient and experimental conditions. The estuary is shallow, turbid, and well-oxygenated, with salinities mostly in the range 2-15%. Dinoflagellates dominate the phytoplankton, especially during winter blooms of Heterocapsa triquetra. Filterable reactive phosphorus (mostly orthophosphate) concentrations were relatively high in the estuary, especially in the middle reaches during summer. Ammonium and nitrate concentrations, however, were relatively low; nitrate was only above 1 microgram-at N/l during winter periods of heavy freshwater inputs. Most of the particulate-P and particulate-N appeared to be phytoplankton. Phytoplankton productivity ranged from 1-4 microgram-at C/lh during most of the year, but exceeded 16 micrograms-at C/lh during winter blooms and in September 1976 when cell counts were relatively low. Phytoplankton seemed to account for most of P-uptake in the estuary, with rates being very high during algal blooms. (Kiger-North Carolina)
W79-09057

TRANSIENT ANALYSIS OF WATER QUALITY,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Chemical and Biochemical Engineering.
B. Davidson, R. Vichnevetsky, and R. Chella.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 187, Price codes: A02 in paper copy, A01 in microfiche. Final Technical Completion Report, Water Resources Research Institute, Rutgers University, April 6, 1979. 3 p. OWRT A-045-NJ(4), 14-34-0001-8032.

Descriptors: *Estuaries, *Dispersion, Model studies, Roughness coefficient.

The research project was designed to formulate an intra-tidal-time, deterministic, one-dimensional, non-isothermal, multistate-variable, water quality model for the Upper Delaware River estuary system. The results achieved include the develop-

ment of numerical techniques for estimating best-distributed Manning's roughness coefficients for open estuarial river systems. The publication giving these results is cited. (See W79-03115) (Whipple-New Jersey)
W79-09059

USER GUIDE FOR THE ENHANCED HYDRODYNAMICAL-NUMERICAL MODEL,
Compass Systems, Inc., San Diego, CA.
A. D. Stroud, and R. A. Bauer.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-288 464, Price codes: A08 in paper copy, A01 in microfiche. Report No. EPA-600/3-78-074, July 1978. Prepared for the U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory, Oregon. 149 p, 6 fig, 12 tab, 9 ref, 6 append. 68-03-2225.

Descriptors: *User guides, *Mathematical models, *Hydrodynamics, *Tidal waters, *Synthetic hydrology, Thermal pollution, Monte Carlo methods, Tidal marshes, Coastal marshes, Advection, Currents(Water), Tidal flats, Upwelling, Heat budget, Boundaries(Surfaces), Linear programming.

Documentation needed for use of the Enhanced Hydrodynamical-Numerical (HN) Model for near-shore processes is presented. The model is a multi-layer Hansen type with a non-linear extension, a layer disappearance extension, a thermal advection enhancement, and a Monte Carlo diffusion enhancement. The model consists of four separate programs, Phases I, II, III, and IV, all coded to run on a CDC 6000-7000 series computer. A single program library documented in the guide includes Phases I, II, and IV. Phase I produces the initial geographic data set. Phase II, the main computational routine, solves the hydrodynamic equation set which can include as options the non-linear convection term and the treatment of areas where a layer disappears. As an option it also advects a set of points using Monte Carlo techniques. Phase IV uses the HN velocity fields as input to the Pedersen-Prahm advection method and decays the heat content of the advected volume. The guide provides library structure, usage and maintenance, and notes on implementation of the model. Program notes, listings, sample runs, and module listings are included as appendices. (Seigler-IPA)
W79-09067

ENHANCED HYDRODYNAMICAL-NUMERICAL MODEL FOR NEAR-SHORE PROCESSES,
Compass Systems, Inc., San Diego, CA.
R. A. Bauer, and A. D. Stroud.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-287 887, Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA-600/3-78-073, July 1978. Prepared for the U.S. Environmental Protection Agency. Corvallis Environmental Research Laboratory, Oregon. 66 p, 29 fig, 6 tab, 23 ref, 1 append. 68-03-2225.

Descriptors: *Mathematical models, *Hydrodynamics, *Tidal waters, *Synthetic hydrology, Thermal pollution, Monte Carlo methods, Tidal marshes, Coastal marshes, Advection, Currents(Water), Tidal flats, Upwelling, Heat budget, Boundaries(Surfaces), Linear programming.

An optimized multilayer Hansen type Hydrodynamical-Numerical (HN) model is presented with extensions and enhancements to allow more accurate modeling of the dynamics of near-shore processes. This version of the HN model combines the vertically integrated single layer HN model and the multilayered multiple-open boundary HN model. Extensions and enhancements are: a non-linear term extension to improve small-mesh studies of coastal areas, a layer disappearance extension to enable correct procedures in marshy regions, a thermal advection enhancement to allow for thermal pollution consideration, and a Monte Carlo diffusion enhancement for dispersion procedures. Results of procedural model verification showed that a non-linear (convection) term should be incorporated whenever an HN application is expected to have significant current gradients. The layer disappearance extension and the thermal advection enhancement were both successful within the assumptions made. The Monte Carlo technique compared favorably to the conservative advection by method of moments in terms of quantitative results. Only procedural verification of the extensions and enhancements is provided. (Seigler-IPA)
W79-09068

THE DYNAMICS OF AN ESTUARY AS A NATURAL ECOSYSTEM, II,
South Carolina Univ., Columbia. Belle W. Baruch Inst. for Marine Biology and Coastal Research.
F. J. Vernberg, W. Kitchens, H. McKellar, K. Summers, and R. Bonnell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-289 963, Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA-600/3-78-092, October 1978. Prepared for the U.S. Environmental Protection Agency, Environmental Research Laboratory, Gulf Breeze, Florida. 85 p, 13 fig, 7 tab, 57 ref, 1 append. R 804407-01.

Descriptors: *Estuarine environment, *Ecosystems, *Dynamics, Aquatic environment, Estuaries, South Carolina, North Inlet Estuary, Bioassay, Analytical techniques, Environmental effects, Simulation analysis, Grasses.

A study on the ecosystem dynamics of a relatively undisturbed estuary, the North Inlet Estuary, near Georgetown, South Carolina, is presented. Two separate but interrelated substudies are described: (1) a macroecosystem study to examine the dynamics of the ecosystem, and develop and update a model of an estuarine ecosystem which would predict probable effects of environmental perturbation; and (2) a microecosystem study to develop and test replicate experimental salt marsh units as diagnostic tools for the assessment of both long- and short-term pollution effects on the Spartina alterniflora salt marsh community. Results included an update and simulation studies of an energy flow model and a more detailed investigation of the applicability of a microecosystem for assessing environmental perturbation. Three recommendations were made: (1) study of relatively undisturbed ecosystems is necessary in order to understand the dynamics of how systems work and to serve as a vital baseline of comparisons; (2) granting agencies need to recognize the need for supporting such long-term projects; and (3) this phase of the study should be continued. (See also W78-11966) (Schaefer-IPA)
W79-09075

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

DEVELOPMENT OF COMPOSITE HOLLOW FIBERS,
Bend Research, Inc., OR.
R. W. Baker, R. P. Barss, and H. K. Lonsdale.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 014, Price codes: A03 in paper copy, A01 in microfiche. Final report of Phase I, June 1979. 40 p, 19 fig, 7 tab, 10 ref. OWRT S-0017(no. 7552)(1), 14-34-0001-7552.

Descriptors: *Reverse osmosis, *Desalination, Hollow fibers, Fiber spinning, Composite membrane.

The objective of this program is to demonstrate the feasibility of using inside-skinned composite hollow fibers for brackish water desalination via reverse osmosis. Composite hollow fibers potted in modules with tube-side feed should be more resistant to fouling and less expensive than current module designs, partly because expensive pretreatment of the feed is unnecessary and partly because the fibers are self-supporting and do not require expensive pressure-containment vessels. The performance of these fibers compares favorably with current cellulose acetate brackish water membranes, and is superior to commercial brackish water hollow fiber systems. (Rykken-Bend)
W79-09053

3D. Conservation In Domestic and Municipal Use

MUNICIPAL WATER DEMAND MANAGEMENT,
Toronto Univ. (Ontario). Dept. of Geography.
A. P. Grima.
Water Spectrum, Vol. 11, No. 3, p 27-35, Summer 1979. 9 fig, 1 tab, 2 ref.

Descriptors: *Domestic water, *Municipal water, *Water conservation, Measurement, Water measurement, Water consumption(Except consumptive use), Water quality, Potable water, Water types, Pricing, Water rates, Elasticity of demand.

The uses, costs, alternatives, metering, pricing, and variables affecting municipal water are examined. Safe, potable water has become increasingly expensive even where water resources are relatively plentiful. Due to the increase in investment costs and other cost factors it is opportune to investigate whether these costs for the residential water supply could be reduced by conservation, and if so, how and by how much. Metering and the design of more rational water rates achieved substantial reduction in municipal water use in general and residential water use in particular. Supply, environmental and socio-economic conditions, and quality of service affect municipal water use. Education of consumers has resulted in conservation. Metering, accompanied by a suitable consumption charge, tends to reduce sprinkling use and other uses on the critical maximum day and peak hour; metering does not affect high priority in-house uses such as washing, cooking, and bathroom use. Expenditures on main transmission and local distribution are affected only marginally by reduction in water demand; development of sources and provision of pumping, purification and local storage facilities are affected directly. A more rational approach to water rates could reduce pressure on required investment for municipal water supply and sewage. Reductions in water use and effluent discharges would produce pressures on water quality in lakes and rivers. (Schaefer-IPA)
W79-09062

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

RELEVANCE OF IFYGL,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 5C.
W79-08873

4D. Watershed Protection

HYDROLOGIC ENGINEERING METHODS FOR WATER RESOURCES DEVELOPMENT. VOLUME 12, SEDIMENT TRANSPORT,
Hydrologic Engineering Center, Davis, CA.
W. A. Thomas.
Available from the National Technical Information Service, Springfield, VA 22161 as AD-A052 600, Price codes: A10 in paper copy, A01 in microfiche. Report HEC-IHD-1200, June 1977. 211 p, 25 fig, 17 tab, 16 ref, 7 append.

Descriptors: *Sediment transport, *Methodology, *Analytical techniques, *Reservoirs, *Streams,

*Mathematical studies, Model studies, Sediments, Channel morphology, Rivers, Simulation analysis, Computer models, Soil erosion, Watersheds(Basins), Data collections, Aggradation, Degradation, International Hydrological Decade, Hydraulic engineering, Water resources development.

One volume of a 12-part series on hydrological engineering methods for water resources development prepared for the International Hydrological Decade deals with movement of sediment in flowing water, including processes of scour, transport, and deposition of inorganic material in free-flowing streams and in reservoirs. River morphology, data collection and analysis, reservoir sedimentation, and aggradation and degradation in streams are discussed. Practical approaches and techniques for analyzing sediment problems are emphasized. Information is provided on application of digital computer simulation to calculation of the volume and location of sediment deposits in reservoirs, and to predicting aggradation or degradation trends downstream from dams and in free-flowing streams. Some sediment transport formulas are included. Specific goals were to: (1) identify potential problem areas, (2) determine which can be analyzed with existing mathematical techniques and which one require movable-bed hydraulic models or the prototype, (3) determine type and quantity of data needed for problem-solving, and (4) provide a guide for solving sediment problems. Analysis of such problems may be approached in three steps: (1) calibrate the analytical technique, (2) verify the procedure with a base test for comparison with observed conditions, and (3) interpret effects of changes by reference to the base test rather than to absolute magnitudes. (Lynch-Wisconsin)
W79-08831

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

COMPARISONS OF MODELS PREDICTING AMBIENT LAKE PHOSPHORUS CONCENTRATIONS,
Environmental Monitoring and Support Lab., Las Vegas, NV.
S. C. Hern, V. W. Lambou, and L. R. Williams.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-293 637, Price codes: A02 in paper copy, A01 in microfiche. Report No. EPA-600/3-79-012, February 1979. 14 p, 3 tab, 10 ref.

Descriptors: *Trophic level, *Mathematical models, *Phosphorus, *Lakes, *Eutrophication, Water pollution, Water quality, Vollenweider model, Dillion model, Larsen/Mercier model, Rates, Oligotrophy, Mesotrophy, Mathematical studies.

The Vollenweider, Dillion, and Larsen/Mercier models are discussed, applied, and compared. Ambient lake phosphorus concentrations in 39 lakes calculated by applying each model are compared in a table to the known concentrations determined by the National Eutrophication Survey (NES). Spearman rank correlation coefficients were calculated for each trophic ratio against measured ambient phosphorus concentrations. Results are: Larsen/Mercier (0.94), Dillion (0.92), and Vollenweider (0.82). The Larsen/Mercier model and the Dillion model, both of which take into consideration the phosphorus retention capacity of lakes, provided the closest estimations. The Vollenweider model, which does not contain a phosphorus retention capacity element, produced the poorest estimate of ambient phosphorus concentration. Trophic states (eutrophic, mesotrophic, and oligotrophic) were calculated and compared to the NES trophic state assignments. Results show a 14, 18, and 25 percent disagreement, respectively, for the Dillion, Larsen/Mercier, and Vollenweider models. Values from two western reservoirs are used to illustrate factors that must be considered for using each model such as phosphorus retention capacities, information needed, flushing rate, mean lake depth, and the theoretical eutrophic 'loading' rate. (Seigler-IPA)
W79-09070

GROUNDWATER QUALITY MONITORING OF WESTERN COAL STRIP MINING: IDENTIFICATION AND PRIORITY RANKING OF POTENTIAL POLLUTION SOURCES.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-293 457, Price codes: A12 in paper copy, A01 in microfiche. Interagency Energy-Environment Research and Development Program Report No. EPA-600/7-79-024. January 1979. Everett, L. G., Ed. Prepared for the U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 26

Descriptors: *Strip mines, *Coal mine wastes, *Pollutant identification, *Groundwater-surface relationships, *Monitoring, Coal mines, Water pollution sources, Water quality control, Groundwater, Mining, Industrial wastes, Waste disposal, Analytical techniques, Water pollution, Waste water(Pollution).

The first phase of a project to design a system to monitor the impact of western coal strip mining on groundwater quality is presented. This phase includes the field survey and literature research to identify and rank the major sources of groundwater quality degradation. The study site follows the outcrop of the Fort Union Formation in Campbell County, Wyoming. Priority ranking, which will serve as the basis for the design of a monitoring plan, was based upon a sequence of data compilation and evaluation steps including: identification of potential pollution sources, methods of waste disposal, and potential pollutants associated with the various waste sources; and an assessment of the potential for infiltration and subsequent mobility of these pollutants in the subsurface. Pit discharge represents a potential source of groundwater pollution for active mining; the changing chemical environment caused by the relocation of spoils is a permanent potential source. Spoils placed below the water table should have top priority among mining sources because of the very polluting nature of the spoils placed there and the contact of those spoils with groundwater. Second priority should be given to rerouted surface water percolating into the spoils. For coal conversion activities, top priority should be given to fly ash landfill disposal below groundwater level; second priority should be the fly ash slurry pond. (Schaefer-IPA)
W79-09071

GROUNDWATER QUALITY MONITORING OF WESTERN OIL SHALE DEVELOPMENT: IDENTIFICATION AND PRIORITY RANKING OF POTENTIAL POLLUTION SOURCES.
Interagency Energy-Environmental Research and Development Program Report No. EPA-600/7-79-023, January 1979. Slawson, G. C., Jr., Ed. Prepared for the U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 238 p, 82 fig, 40 tab, 72 ref, 1 append. 68-03-2449.

Descriptors: *Oil shales, *Pollutant identification, *Monitoring, *Groundwater-surface relationships, *Water pollution sources, Water quality control, Groundwater, Mining, Industrial wastes, Waste disposal, Analytical techniques, Water pollution, Waste water(Pollution).

The first phase of a project to design a system to monitor the impact of western oil shale development on groundwater quality is presented. The phase included the field survey and literature research to identify and rank the major sources of groundwater quality degradation. The oil shale operation proposed for the eastern Utah test site includes room-and-pillar mining, surface retorting by the Paraho and TOSCO II process, and surface disposal of spent oil shale. Priority ranking which will serve as the basis for the monitoring plan, was based on a sequence of data compilation and evaluation steps including: identification of potential pollution sources, methods of waste disposal, and potential pollutants associated with the various waste sources; and an assessment of the potential for infiltration and subsequent mobility of these pollutants in the subsurface. Over two dozen potential sources of groundwater quality impact were identified; these include elements of extraction, retorting, upgrading, and waste disposal processes, as well as highly variable elements such as storm runoff. The highest priority potential pollutants associated with each area were identified; those for the spent shale area were spent shale, high total dissolved solids wastewater, sour water, retort water, and spent catalysts; spent shale was the highest source for retention dams; those for the process area were the proposed effluent holding pond, raw shale storage, and tankage area. (Schaefer-IPA)
W79-09072

A STUDY OF THE PHYSICO-CHEMICAL FORMS OF TRACE METALS IN NATURAL WATERS AND WASTEWATERS,
Caulfield Inst. of Tech., Victoria (Australia). Water Studies Center.
B. T. Hart, and S. H. Davies.
Australian Water Resources Council Technical Paper No. 35, 1978. 206 p, 18 fig, 42 tab, 207 ref, 2 append. Australian Government Publishing Service, Canberra. 74/60.

Descriptors: *Trace elements, *Physicochemical properties, Australia, Water chemistry, Properties, Physical properties, Chemical properties, Biological properties, Analytical methodologies, Aquatic environment, Cadmium, Iron, Copper, Lead, Zinc.

Research aimed at the development and application of analytical methodologies to provide useful information on the physico-chemical forms of selected trace metals in Australian waters is presented. Evidence indicated that the form of the metal can significantly influence the types of interactions occurring between trace metals and the various components of aquatic systems. These components include the biota, sediments, suspended particulates, and water. In order to have a complete understanding of the fate and biological activity of trace metals in aquatic systems, it is essential to have a knowledge of their speciation. A short review on the current state of knowledge on the speciation of cadmium, copper, lead, zinc, and iron, the main processes likely to influence the forms present, and the implications of the metal forms on their mobility and biological activity in natural waters is presented. Results of studies aimed at testing a number of potentially useful analytical methodologies for metal speciation are included; the results and discussion of investigations to test the applicability of those methodologies to a wide range of natural waters are reported. Recommendations are made on the use and development of techniques. (Schaefer-IPA)
W79-09080

5B. Sources Of Pollution

HELSINKI METROPOLITAN AREA WATER SUPPLY AND WATER QUALITY IN LAKE PAIJANNE,
Hydrobiological Research Inst., Jyvaskyla (Finland).
For primary bibliographic entry see Field 5C.
W79-08964

TRANSPORT OF OILY POLLUTANTS IN THE COASTAL WATERS OF LAKE MICHIGAN: AN APPLICATION OF RARE EARTH TRACERS,
Argonne National Lab., IL. Energy and Environmental Systems Div.
D. L. McCown, K. D. Saunders, J. H. Allender, J. D. Ditmars, and W. Harrison.
Available from the National Technical Information Service, Springfield, VA 22161 as ANL-WR78-1, Price codes: A06 in paper copy, A01 in microfiche. Report Nos. ANL/WR-78-1 and EPA-600/7-78-230, November 1978. EPA/DOE Interagency Agreement. Prepared for the U.S. Environmental

Protection Agency, Office of Energy, Minerals and Industry and the U.S. Department of Energy, Office of Health and Environme

Descriptors: *Tracers, *Path of pollutants, *Oily water, Rare earths, Dyseprosium, Samarium, Water pollution, Tagging, Tracking techniques, Analytical techniques, Lake Michigan, Chicago, Illinois, Indiana Harbor Canal, Water supply, Water treatment, Filtration, Coasts, Lakes.

Methods were developed for simultaneously tagging and tracing both oily wastes and the underlying waters and for determining their individual motions in fresh coastal waters. Indiana Harbor Canal (IHC) water and simulated oily-wastes on the surface of that water were simultaneously tagged. In a summer and a winter study the tagged cloud was tracked and sampled. Rare earth element (REE) tags (dyseprosium and samarium) were used; neutron activation analysis was used for tag detection and concentrations. Industry along the IHC draws water from Lake Michigan for it cooling process; water returned to the lake via the IHC is heated 5-8 C. In winter, the IHC effluent forms a plume of 4 C water and sinks near the IHC entrance; in summer, the canal effluent flows out on the surface and lake water intrudes into the canal along the bottom. Experiments were conducted for both floating- and sinking-plume conditions. Oily waste artificially mixed downward by a ship in the floating-plume study did not resurface; no differences were seen in the movement of the oily waste and underlying water; calculated diffusion coefficients for the REE tags were similar to values measured by others on the Great Lakes. The sinking-plume study showed unequivocal evidence of the transport of polluted IHC water to Chicago's South Water Filtration Plant; partitioning of oily wastes and water were indicated. Plume center-line dilution ratios for the entire IHC effluent plume were indicated to be as low as 2.8. (Schaefer-IPA)
W79-09074

5C. Effects Of Pollution

ZOOBENTHOS OF LAKES,
Copenhagen Univ. (Denmark). Freshwater Biological Lab.
P. M. Jonasson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 13-37. 19 fig, 2 tab, 64 ref.

Descriptors: *Benthic fauna, *Food habits, *Depth, *Lakes, *Lake Esrom(Denmark), *Energy, Ecosystems, Ecology, Food webs, Productivity, Organic matter, Trophic level, Eutrophication, Species diversity, Growth rates, Succession, Denmark, Habitats, Hydrobiology, Biological communities, Feeding rates, Invertebrates, Limnology.

Research concerning zoobenthos in eutrophic Lake Esrom, Denmark shows that distribution of organic matter in aa lake basin profoundly influences zoobenthic species diversity, type of feeding, growth, biomass accumulation, population dynamics, and production, as well as turnover rates (P/B) of materials. Food is usually the most important factor influencing distribution of closely related species in eutrophic lakes. In Lake Esrom net profundal production equals net zooplankton production, and in the littoral and sublittoral it is higher; if metabolism is included, a much greater share of total energy flow passes through the benthic community than through zooplankton. This phenomenon should prove true for most lakes. The amount of available organic matter determines the total quantity of zoobenthos in many lakes. Faster growth in the littoral often allows more generations per time unit; many species are bivoltine. Herbivores often have high production and turnover rates, almost reaching the high zooplankton turnover rates. The surface feeders, which have periodic access to fresh food of high energy, have much higher growth rates and shorter life cycle than subsurface feeders. (Lynch-Wisconsin)
W79-08833

GROWTH OF THE UNICELLULAR ALGA SELENASTRUM CAPRICORNUTUM AS A FUNCTION OF P. WITH SOME INFORMATION ALSO ON N,
E. Steemann Nielsen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 38-42. 2 fig, 15 ref.

Descriptors: *Phosphorus, *Limiting factors, *Plant growth, *Growth rates, *Selenastrum capricornutum, *Culture media, *Testing procedures, *Laboratory tests, Chlorophyta, Unicellular algae, Nutrients, Nitrogen, Nitrates, Ammonium, Phosphates, Algae, Cultures, Chemostats, Half-saturation constant.

Phosphorus concentration required for growth of the unicellular chlorophyte Selenastrum capricornutum was investigated, and it was found that the type of culture medium and methodology were greatly significant in investigating the growth rate. The medium ordinarily used, Osterlind B, was not suitable for phosphorus determinations because it contained iron as the citrate, and a considerable part of the phosphate was bound and therefore unavailable to the algae. This fact led to the erroneous conclusion in other studies that a high phosphorus concentration is needed for optimal growth, when in fact extremely low concentrations ordinarily are sufficient for growth of unicellular algae. In addition, even with chemostats (as opposed to batch cultures) excessively high algal concentrations must be avoided to prevent possible production of autoinhibitors. In S. capricornutum, growth stops at three billion cells/l. In the revised tests, a modified Osterlind B medium was used, with micronutrienrs and cobalt, which contained EDTA in place of citric acid. A special counting technique was employed involving centrifugation. The half-saturation constant was 0.007 micro-atom P/l, compared with 0.3 microg-atom P with ordinary Osterlind B medium. Experiments with nitrate showed a half-saturation constant of 0.05 microg-atom N, whereas in ammonium tests at a concentration of 0.02 microg-atom N growth rate was 75% of the optimum. (Lynch-Wisconsin)
W79-08834

AN IMPROVED OXYGEN METHOD FOR MEASURING PRIMARY PRODUCTION IN LAKES,
Bern Univ. (Switzerland). Zoologisches Inst.
P. A. Tschumi, D. Zbaren, and J. Zbaren.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 43-48. 2 fig, 2 tab, 14 ref.

Descriptors: *Lakes, *Primary productivity, *Winkler method, *Measurement, *Methodology, *Oxygen method, *Testing procedures, Lake Bienne(Switzerland), Switzerland, Eutrophication, Volumetric analysis, Phototitration, Light, Darkness, Negative respiration, Sampling.

Improvements are described which overcome earlier problems in measuring primary productivity in eutrophic Lake Bienne in northwestern Switzerland using the Winkler oxygen method. Problems were: (1) imprecise oxygen determinations, especially during winter full circulation and with conditions of low productivity; and (2) occurrence of 'negative respiration,' significantly higher content of the exposed dark bottles compared with initial levels. The Winkler technique used for the light and dark bottle method was made 5-10 times more accurate by detecting the titration end-point photometrically, and by strictly standardizing all manipulations preceeding and during titration. But improved precision is possible only if not overshadowed by other sources of error, two of which are discussed here: (1) release of oxygen upon illuminating dark-adapted lake water before adding the Winkler reagents, and (2) instability of the oxygen concentration of undersaturated or oversaturated water. The first problem can be eliminated by opening bottles and adding the reagents in complete darkness. The second problem can be reduced by placing a swimming disc which is slightly smaller than the inside diameter of the sampler (to allow for free movement) on the water column. The disc considerably reduces direct contact and gas exchange between water and air. Attention to the sample bottle filling order is also helpful. (Lynch-Wisconsin)
W79-08835

FACTORS AFFECTING REMOVAL OF INORGANIC 14C FROM WATER,
Wayne State Univ., Detroit, MI. Dept. of Biology.
R. A. Hough, and G. J. Filbin.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theore-tische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 49-53. 1 fig, 3 tab, 11 ref. NSFGB-40311.

Descriptors: *Carbon radioisotopes, *Acidification, *Sparging, *Primary productivity, *Testing procedures, *Measurement, Inorganic compounds, Organic compounds, Michigan, Lakes, Bogs, Dissolved organ carbon, Bicarbonates, Carbonates, Water chemistry, Chelation, Buffers, Carbon dioxide, Laboratory tests, Methodology, Volume, Nutrient removal, Tracers, Lake St. Clair(MI), Heart Lake(MI), Carbon.

Removal of inorganic carbon-14 from water by acidification and gas sparging has become a common method of quantifying carbon-14 organic compounds released during primary production; this study investigates possible overestimation of organic carbon-14 with use of the method. Evaluation of the rate of carbon-14 bicarbonate removal shows that at the sparging flow rate which was used inorganic media and lake water samples of low dissolved organic content apparently can be purged of inorganic carbon within 3-4 minutes with no residual contamination. However, data suggest that some kinds of organic compounds can retard removal of inorganic carbon, in this case most notably tris buffer and compounds in bog lake water, and support suggestions that sparging times of 10 minutes or more should be used. The inorganic-organic carbon interaction appears to be fully reversible, and is not influenced by long-term incubation prior to acidification, such as would be used in carbon-14 productivity measurements, and with reasonable sparging duration it is not likely to cause experimental error. In these tests, both a laboratory growth medium and filtered lake water samples were used, the latter taken from two Michigan lakes, Lake St. Clair and Heart Lake (a young Sphagnum bog lake). Inorganic carbon-14 was removed within one min from a four-ml volume of inorganic growth medium by acidification and nitrogen sparging, and within two min from a 20-ml volume. Organic buffer or chelator increased removal time. (Lynch-Wisconsin)
W79-08836

THE PH-CO2 RELATIONSHIP IN NATURAL WATERS,
State Univ. of New York Coll. at Fredonia.
K. G. Wood.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 54-58. 2 fig, 1 tab, 4 ref.

Descriptors: *Carbon dioxide, *Total carbon dioxide, *Hydrogen ion concentration, *Acidity, *Alkalinity, *Methodology, Lakes, Ponds, Acid precipitation, New York, Meadow Pond(NY), Kitten Pond(NY), Adirondack Park(NY), Acidic waters, Equations, Volumetric analysis, Respiration, Silicates, Borates, Equilibrium.

A new method used for computing the respiratory quotient in the hypolimnion of Lake Erie, based on total carbon dioxide, was described in 1972; this paper presents a corrected equation for total carbon dioxide (given by Stumm and Morgan 1970), and tests it under various conditions of alkalinity and with added silicate and borate. The

original equation lacked corrections in the alkalinity term. With the new method, a duplicate sample of water is equilibrated with air at standard temperature, the pH and alkalinity are measured, and total CO2 is computed. Total CO2 is similarly determined for the unaerated sample; the difference between the two is D-CO2. This new form of CO2 is similar to free CO2, but the point of reference is changed from pH 8.34 to the pH at air equilibrium. As waters of alkalinity greater than 560 micro-equiv/1 (most freshwaters) will reach air equilibrium at pH 8 or above, the numerical difference between D-CO2 and free CO2 may be slight, but D-CO2 can be positive or negative and allows computation of the degree of air saturation of CO2. It is concluded that the corrected equation will be most useful when X components are small relative to alkalinity. Effects of X components can be identified by various methods. For many natural waters the D-CO2 can be calculated by the unmodified equation. Water samples from two ponds in Adirondack Park, New York, affected by aicd rain. Meadow Pond (total alkalinity 36.3 microequiv/1, SiO2 64 micromole/1) and Kitten Pond (123.5 microequiv/1 and 54 micromole/1 respectively). (Lynch-Wisconsin)
W79-08837

A PROCEDURE FOR IMPROVING ESTIMATES OF IN SITU PRIMARY PRODUCTION AT LOW IRRADIANCES WITH AN INCUBATOR TECHNIQUE,
Fisheries and Marine Service, Winnipeg (Manitoba). Freshwater Inst.
E. J. Fee.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 59-67. 2 fig, 5 tab, 22 ref.

Descriptors: *Primary productivity, *Algae, *Measurement, *Methodology, *Mathematical models, *Lakes, *Light intensity, Phytoplankton, Chrysophyta, Flagellates, Estimating, Testing procedures, Incubation, Experimental Lakes Area(Ontario-Canada), Ontario(Canada), Canada, Model studies, Solar radiation, Light penetration, Thermocline, Hypolimnion, Epilimnion, Depth, Turbidity, Eutrophication, Calibration, Photosynthesis.

The author's earlier (1973) numerical model for estimating primary productivity grossly overestimates hypolimnetic primary production, due to errors in the slopes of photosynthesis-vs-light curves which only become important at subsaturating irradiances. The error did not appear previously because all model verifications were carried out in epilimnetic waters at saturating irradiances. In situations where total production occurs mostly at subsaturating irradiance, (usually in the thermocline and hypolimnion but in more turbid lakes also in much of the epilimnion) incubator irradiances should be corrected at depths below the level of 10% light penetration to ensure greatest accuracy. Differences in spectral composition of the light between incubator and lake are the most likely source of the error. The best correction procedure is to tune incubator photosynthesis-vs-light curves with in-situ results. The error was discovered in studies of Lake 226 and 302 in the Experimental Lakes Area of Ontario, Canada, in which massive concentrations of chrysophyte algae were found in the thermocline and hypolimnion. The algae were flagellated net plankton and so apparently had minimal zooplankton grazing and sedimentation losses. While model primary production data gave doubling times of 3-10 days, the blooms appeared intuitively to be the result of a slow process of biomass accumulation with low mortality. To resolve the matter, in 1976 simultaneous in-situ and model measurements of primary production were made. (Lynch-Wisconsin)
W79-08838

NATURAL COMMUNITY BIOASSAYS: PREDICTIONS OF RESULTS BASED ON NUTRIENT PHYSIOLOGY AND COMPETITION,
Michigan Univ., Ann Arbor. Div. of Biological Sciences.
S. S. Kilham, and P. Kilham.
In: Proceedings: 20th Congress, International Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 68-74, 2 fig, 1 tab, 24 ref. NSF OCE76-10183.

Descriptors: *Bioassay, *Biological communities, *Phytoplankton, *Nutrients, *Competition, *Plant physiology, Forecasting, Algae, Chrysophyta, Diatoms, Asterionella formosa, Fragilaria crotonensis, Stephanodiscus minutus, Abundance, Dominant organisms, Equilibrium, Lake Michigan, Great Lakes, Lakes, Succession, Eutrophication, Food chains, Growth rates, Model studies, Mathematical models, Phosphates, Silicon, Phosphorus, Silicates.

Using data for Lake Michigan taken from Schelske, et. al. (1974) and Stoermer, et. al. (in preparation), an analysis was made of the importance of relative proportions of nutrients (rather than concentrations) in determining interactions of phytoplankton species. While nutrient concentrations and rate of supply determine total yield of cells, their proportions are important in determining which species increase and which decrease in relative abundance due to competition for nutrients. Resource competition theory provides the framework for formulating predictions of nutrient-addition effects, and laboratory nutrient growth experiments on individual species provide basic data. Bioassay experiments are performed ideally in semi-continuous or continuous culture, varying nutrients along a gradient. Competitive interactions of species are determined by the relative ability of each to use the nutrients. In the data utilized, shifts in dominant species of diatoms along a silicon/phosphorus gradient is discussed. Asterionella formosa was a successful competitor at high Si/P ratios, Fragilaria crotonensis became dominant at intermediate ratios, and Stephanodiscus minutus grew best at low ratios. These species are useful standards for comparisons with other diatom species. While interactions of green and blue-green algae along a nitrogen/phosphorus gradient could also be analyzed, only scanty physiological information was available. (Lynch-Wisconsin)
W79-08839

VALIDITY OF 32P KINETIC EXPERIMENTS IN ALGAE,
Weizmann Inst. of Science, Rehovoth (Israel). Isotope Dept.
M. Stiller, M. Edelstein, H. Volohonsky, and C. Serruya.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 75-81, 5 fig, 2 tab, 6 ref. EPA R803120-01-0.

Descriptors: *Kinetics, *Phosphorus, *Absorption, *Phytoplankton, *Ankistrodesmus nannoselenae, *Testing procedures, Algae, Equilibrium, Laboratory tests, Darkness, Light, Nutrients, Model studies, Mathematical models, Lakes, Organic matter, Phosphates, Tracers, Chlorophyta.

Axenic cultures of the chlorophyte Ankistrodesmus nannoselenae were grown in synthetic Lake Kinneret (Israel) water. This technique was used to avoid the problem of seston in determining phosphorus uptake by algae; it has been demonstrated that dead organic matter is responsible for the disappearance of a certain fraction of P-32 from the water. Low molecular weight phosphorus compounds are excreted back as anionic forms, which may combine with colloids and be released as PO4(-3) available for algal uptake. This study was carried out to determine whether in such a simple system the phosphorus exchange and phosphorus uptake experiments were reproducible and could be interpreted by Lean and Nalewajko's two-compartment model (1976). Conclusions: (1) in steady-state tests, reproducibility of the slope was better in both dark and light runs than that of the isotopic equilibrium ratio (IER); (2) under non-steady-state conditions the reproducibility of the uptake rate constant of PO4(-3) (K sub f) in runs with addition of 14.8 ppb P was poor; (3) in dark conditions the intracellular P-32 increased and the exchange rate, estimated by assuming steady-state conditions, decreased by 40%; and (4) while the P-32 technique offers simplicity, interpretation of kinetic experiments still lacks an inter-disciplinary insight. The two-compartment model includes dissolved PO4(-3) in water and intracellular P. These results may suggest the existence of more than one intracellular component. (Lynch-Wisconsin)
W79-08840

A LABORATORY EXPERIMENT TO EXAMINE THE EFFECTS OF NUTRIENT ENRICHMENT ON MACROPHYTE AND EPIPHYTE GROWTH,
University of East Anglia, Norwich (England). School of Environmental Sciences.
D. Eminson, and G. Phillips.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 82-87, 3 fig, 1 tab, 23 ref.

Descriptors: *Norfolk Broads(England), *Eutrophication, *Nutrients, *Competition, *Macrophytes, *Epiphytes, *Phytoplankton, Algae, Najas marina, Oedogonium, Filamentous algae, Laboratory tests, Lakes, Shallow lakes, Shading, Plant growth, Succession, Diatoms, Chrysophyta, Water pollution effects.

Declines in macrophyte growth and diversity which have often accompanied nutrient enrichment of lakes appear to be more a result of increased growth of epiphytic or filamentous algae than of phytoplankton shading, at least in shallow lakes. Laboratory experiments with the macrophyte Najas marina grown in tanks filled with water from Upton Broad, a shallow lake in the Norfold Broads, England, suggested the following succession mechanism: (1) Without large amounts of nitrogen and phosphorus in the water, rooted aquatic macrophytes may dominate a lake through the competitive advantage of using sediments as a nutrient source. (2) With somewhat more nutrient availability an algal flora develops on the macrophytes which receives a continuous fresh supply of nutrients as water moves past them; they thus obtain a competitive advantage over phytoplankton which acquire nutrient deficient water layers around them and move less than the epiphytes relative to the adjacent water. (3) Only when the nutrient concentration exceeds the demand of macrophytes and epiphytes do phytoplankton develop. Increased phytoplankton crops did not occur in the experimental tanks, apparently a result of competition by epiphytic and filamentous algae for nutrients. Enrichment resulted in decreased macrophyte growth and increased standing crop of diatom epiphytes. After day 14 diatoms on N. marina declined; by day 20 the filamentous alga Oedogonium surrounded the plants; and was itself covered by diatoms. The shift of diatoms to Oedogonium was probably due to shading by the latter, which may also have accounted for the decline of the macrophytes. (Lynch-Wisconsin)
W79-08841

PRIMARY PRODUCTIVITY IN THE SUBMERGED AQUATIC MACROPHYTE CERATOPHYLLUM DEMERSUM,
Hydrobiologisch Inst., Nieuwersluis (Netherlands).
E. P. H. Best, and J. T. Meulemans.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 88-93, 3 fig, 3 tab, 10 ref.

Descriptors: *Primary productivity, *Photosynthesis, *Ceratophyllum demersum, *Macrophytes, *Lake Vechten(Netherlands), *Carbon cycle, Carbon radioisotopes, Incubation, Seasonal, Growth stages, Plant growth, Bicarbonates, Carbon dioxide, Light, Darkness, Respiration, Tracers, Excretion, Hydrogen ion concentration, Absorption, Carbon cycling nutrients, Netherlands, Submerged plants, Dormancy.

Primary productivity, respiration, and excretion of the submerged aquatic macrophyte Ceratophyllum demersum were studied to determine the plant's

role in the carbon cycle of Lake Vechten, Netherlands. Photosynthetic activities in the plant's two distinct seasonal physiological and morphological stages were measured: (1) the normal vegetative stage occurring in the summer and characterized by vigorous growth and a long axis with whorls of slender leaves, and (2) the dormant stage in winter when no growth occurs and plants have short internodes and thick, brittle leaves. Carbon fixation was much higher at pH 6 than at the lake's normal pH 7-8, indicating photosynthetic use of CO_2 rather than bicarbonate. Release of carbon dioxide and organic carbon from labelled plants under various conditions was followed to determine the magnitude of dark and light respiration relative to carbon fixation. Most experiments were carried out with preconditioned tips of C. demersum from a winter culture, consisting of an apex and six whorls of leaves, the most active portions of the plants. The plants were thus harvested in a dormant state, and kept at low light intensity, low temperature, and short day length to lift dormancy. Photosynthesis was highest 2-4 hrs after transfer to experimental conditions, with carbon-14 fixation amounting to 0.002%/mg dry wt/hr (0.3-0.5 mg C/g/hr). Excretion of nongaseous organic compounds was very low, while excretion of carbon-14 carbon dioxide was high. A seasonal photosynthetic effect was detectable. (Lynch-Wisconsin)
W79-08842

BIOMASS AND PRIMARY PRODUCTION IN A PHRAGMITES COMMUNIS TRIN. SWAMP IN NORTH JUTLAND, DENMARK,
Aarhus Univ. (Denmark). Ecological Lab.
H. H. Schierup.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977, Vol. 20, September 1978, Part 1, p 94-99. 5 fig, 13 ref.

Descriptors: *Phragmites communis, *Swamps, *Primary productivity, *Vejlerne Nature Reserve(Denmark), *Biomass, *Wetlands, Denmark, Fjords, Plant growth, Shallow water, Macrophytes, Seasonal, Roots, Rhizomes, Shoots, Reclamation, Bogs.

Variations in the biomass of roots, rhizomes, and aerial portions of a Phragmites communis stand in the swampy Vejlerne Nature Reserve in North Jutland, Denmark, were measured March-October by means of direct harvesting. Roots and rhizomes were separated into live and dead fractions, but only the figures for live rhizomes, quantitatively the most important, were considered reliable. Aerial portions of the plant grew May-August, with maximum biomass 1160 g dry wt/sq m. Net aerial primary production was 1160 g dry wt/sq m/yr, based on the sum of biomass changes, losses by death, and losses by consumers. Rhizome biomass decreased 425 g dry wt/sq m during March-August, and increased 1025 g dry wt/sq m August-October, when aerial parts began to wither. Total annual net production was calculated at 1760 g dry wt/sq m/yr, based on net aerial primary production plus net annual rhizome biomass increase (1025-425 g dry wt/sq m). The Vejlerne reserve is a wetlands system of shallow fjords reclaimed from Lim Fjord in the late 19th Century. P. communis is the dominant emergent macrophyte, with Typha latifolia playing a minor role. Sampling was conducted on 10 occassions in the western part of Han Vejle, the smallest fjord. Above-ground biomass was harvested with a hedge clipper aided by a wooden frame, and below-ground biomass with a corer. (Lynch-Wisconsin)
W79-08843

A METHODOLOGY FOR THE STUDY OF THE TROPHIC INTERACTIONS IN ZOOPLANKTONIC COMMUNITIES,
European Atomic Energy Community, Ispra (Italy).
F. Argentesi, and R. de Bernardi.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 100-104. 2 fig, 3 tab, 9 ref.

Descriptors: *Zooplankton, *Biological communities, *Methodology, *Statistical models, *Predation, *Completion, *Population dynamics, *Time series analysis, *Lago Maggiore(Italy), Trophic level, Mathematical models, Model studies, Analytical techniques, Causality, Mortality, Fecundity, Density, Cladocera, Leptodora kindtii, Bythotrephes longimanus, Daphnia hyalina, Bosmina coregoni, Diaphanosoma brachyurum, Chydorus sphaericus, Italy, Equations.

A mathematical methodology developed earlier for evaluating dynamic parameters of natural single-species zooplankton populations (fecundity and mortality rates) is extended to zooplankton community structure and trophic interactions, starting from population time series (density, fecundity, and mortality). A causality equation is established; from this, a methodology for assessing relationships among time series is developed, representing population dynamics of the zooplankton community. The system considered is a cladoceran community composed of two predators, Leptodora kindtii and Bythotrephes longimanus, and the filter-feeders Daphnia hyalina, Bosmina coregoni, Diaphanosoma brachyurum and Chydorus sphaericus. Only competitive and prey-predator interactions are weighed. For each proposed compartment the following time series data are available: population density in individuals/cu m, fecundity unit rate in eggs/day X female, and mortality unit rate in individual/day X individual. Because not all species were simultaneously present in the study area (Lago Maggiore, Italy), only a limited portion of the total structure could be investigated: interrelationships of Leptodora, Diaphanosoma, and Daphnia young and adults. Six possible relationships were distinguished for causality assessment for which time variables are presented. (Lynch-Wisconsin)
W79-08844

ECOSYSTEM MODELS VS BIOLOGICAL REALITY: EXPERIENCES IN THE SYSTEMS ANALYSIS OF AN ARCTIC POND,
Woods Hole Marine Biological Inst., MA.
J. E. Hobbie, and J. L. Tiwari.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 105-109. 2 fig, 11 ref.

Descriptors: *Computer models, *Ponds, *Arctic, *Ecosystems, *Analytical techniques, *Systems analysis, Model studies, Deterministic models, Stochastic processes, Alaska, Barrow(AK), Simulation analysis, Forecasting, Benthic flora, Algae, Phytoplankton, Zooplankton, Primary productivity, Biomass, Photosynthesis, Seasonal, Light, Water temperature, Sediments, Carbon cycle, Respiration, Excretion, Evaluation.

Evaluation of the usefulnes of computer models developed for arctic ponds, based on research near Barrow, Alaska 1970-74, concludes: (1) available mathematical and computer techniques are adequate for modelling aquatic systems; (2) there is serious misunderstanding of how aquatic ecosystems operate; (3) these gaps prevent the models from being predictive at present; (4) the models are nonetheless useful for identifying research needs; and (5) stochastic models which incorporate natural variability will probably be a realistic way of modelling such ecosystems. The overall model could successfully simulate the seasonal biomass cycle and productivity rates. A stochastic model developed was quite stable, and small changes in sensitive coefficients did not cause such problems as occurred with the deterministic model. Modelling was useful: (1) as an aid to coordination of the project, (2) for requiring concise statements of knowledge and assumptions, and (3) as a means of following carbon flows and testing hypotheses. Negative aspects included: (1) inclusion of processes which could not be measured, (2) the fact that slight tuning adjustments caused great changes in results, (3) certain coefficients were over-sensitive, and (4) the model was not predictive. (Lynch-Wisconsin)
W79-08845

EMPIRICAL PHYSIOLOGICAL MODELS OF ECOSYSTEM PROCESSES,
McGill Univ., Montreal (Quebec). Dept. of Biology.
R. H. Peters.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 110-118. 5 fig, 1 tab, 29 ref.

Descriptors: *Physiology, *Empirical data, *Aquatic animals, *Body size, *Forecasting, *Mathematical models, *Biomass, *Growth rate, *Biological communities, Model studies, Equations, Ingestion, Egestion, Weight, Detritus, Homeothermy, Poikilothermy, Productivity, Ecosystems, Size, Lakes, Succession, Food habits, Mortality, Feeding rates, Tracers, Simulation analysis, Analytical techniques, Methodology.

Body weight was successfully used to predict such holistic ecosystem properties as successional change and material flow, by means of equations taken from the literature which empirically describe physiological rates as a function of animal body weight. Graphs were constructed in which each point is an empirically determined value for one species representing growth rate and ingestion rate as a function of body weight. The slopes of all curves were taken as 0.75, a well-established 'metabolic scaling factor'. Such collations provide a basis for comparing data for the whole animal kingdom. The curves show an organism's trophic position has little influence on ingestion or production rate, and suggest (probably correctly) that poikilothermy has little effect on production, and (probably incorrectly) that homeothermy has little effect on ingestion. The physiological equations are used to describe a model ecosystem. Five size classes of animals (0.1, 1, 10,100, and 1000 g) were assigned an initial biomass of one g each and a detrital pool of 95 g. The physiology of each size class was defined by empirical relation for respiration, ingestion, growth, and egestion (excretion). The model then linked the size classes through a series of assumed trophic interactions: functional response, size-specific mortality, food-size selection, and random stress. All gave the same qualitative results, namely that succession leads to increased community biomass, larger mean body size, and a more equitable distribution of biomass. (Lynch-Wisconsin)
W79-08846

MODELLING THE EFFECTS OF INFLOW AND ORGANIC SEDIMENT ON NUTRIENT-PLANKTON DISTRIBUTIONS IN LARGE RESERVOIRS,
Washington State Univ., Pullmann.
R. A. Parker.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 119-122. 2 fig, 3 tab, 6 ref.

Descriptors: *Nutrients, *Reservoirs, *Advection, *Sediments, *Diffusion, *Phytoplankton, *Zooplankton, *Mathematical models, *Sediment-water interfaces, Model studies, Mixing, Spatial distribution, Inflow, Organic matter, Detritus, Eddy diffusion, Equations, Equilibrium.

Steady-state solutions are given for a system of nutrient-plankton equations which incorporate mass flow, diffusion, and exchange with sediments having inorganic and organic sources of an essential nutrient, such as phosphorus or nitrogen. In large well-mixed reservoirs showing little thermal stratification, nevertheless spatial heterogeneity of nutrient concentrations and plankton densities often is seen partly dependent on the extent to which dissolved-nutrient-containing compounds are added to or released from sediments. Concurrent action of advection and eddy diffusion has not previously been explored in detail in a model. A ten-fold increase in velocity produces a similar increase in the distance between population peaks. Higher nutrient content also increases period length, but only by about one-third. By contrast, raising organic concentration in the sediment pro-

duces a slight decrease in period, but the concentration in the water rises dramatically with small increases in dissolved inorganic nutrients and zooplankton. Sampling programs designed for large reservoirs could be improved if some sampling stations were located to take advantage of advective effects and if results from fixed sampling locations were compared with those from stations moving with the current. (Lynch-Wisconsin)
W79-08847

MODEL OF FUNCTIONING OF BIOLOGICAL SYSTEM,
Nicolas Copernicus Univ. of Torum (Poland). Inst. of Biology.
R. Bohr.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 123-126. 1 fig, 6 ref.

Descriptors: *Mathematical models, *Information theory, *Systems analysis, *Biological communities, *Analytical techniques, *Oxidation-reduction potential, Methodology, Biology, Model studies, Energy flow, Inorganic compounds, Organic matter, Eutrophication, Phytocenoses, Agrocenoses, Ecology, Ecosystems, Energy.

A model which simulates functioning of any biological system is founded on systems theory and information theory. The model illustrates a selected fragment and moment of ergomatter composed into a biological system, and is based on assumptions of the stability of earthly matter mass and of the cyclic progress in the structure of matter, presented in the form of a scalar drawing comprising an area between two concentric circles. Energy flow direction and intensity are shown by arrows, and the duration and succession of the system's consecutive stages are indicated by clockwise movement of the radius. Inorganic matter is marked with horizontal stripes and organic with vertical stripes; their density reflects the degree of mineralization of the inorganic part, or the organizing level of the organic part. The starting point is matter which has been built into the system by means of energy from outside--i.e., maximally reduced in the chemical sense. This is connected with the establishment of a great difference in the redox potential between the organic and inorganic matter, which necessitates energy transformations in two directions: progressing degradation through loss of energy and lowering of the degree of matter organization, and the contrary process of raising the energetic and structural level of matter by means of the work done from releasing free energy in the first process. The two basic properties of material structure, order and organization, must be considered. (Lynch-Wisconsin)
W79-08848

LIMNOLOGY IN THE HIGH ARCTIC: A CASE STUDY OF CHAR LAKE,
McGill Univ., Montreal (Quebec). Dept. of Biology.
F. H. Rigler.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 127-140. 7 fig, 1 tab, 30 ref.

Descriptors: *Arctic, *Limnology, *Char Lake(Northwest Territories-Canada), *Lakes, *Oligotrophy, Primary productivity, Biomass, Phytoplankton, Zooplankton, Benthic fauna, Benthic flora, Cold regions, Energy flow, Carbon cycle, Eutrophication, Canada, Northwest Territories(Canada), Meretta Lake(Northwest Territories-Canada), Ice cover, Water temperature, Photoperiodism, Nutrients, Limiting factors, Light, Species diversity.

Ultraoligotrophic Char Lake (Northwest Territories, Canada), the only polar lake to have been comprehensively studied, is used to illustrate arctic limnology. Such lakes represent both extreme conditions and a simplified system. Whereas low nutrient loading appears to limit phytoplankton biomass, low temperature controls productions rate, and in consequence the production-to-biomass ratio (0.05-0.07) is lower than in temperate lakes. The benthic community is relatively more important in the arctic than in temperate regions; it is responsible for most primary production and respiration, and has the greatest diversity of species. Obtaining accurate population statistics of benthic organisms in arctic lakes remains a problem. In general there is little sign of adaptation; species merely develop and respire more slowly than at higher temperatures, and therefore respond slowly to environmental change. Long-term studies are thus needed to predict the response of arctic lake systems to increased nutrient loading or basin disturbances, both of which are known to affect the lakes. Char Lake has a mean summer chlorophyll-a level of 0.4 mg/cu m and an average annual phytoplankton primary production of 4.1 g C/sq m/yr. It is by far the most oligotrophic lake ever studied in detail. The nitrogen/phosphorus ratio is 23, and phosphorus loading is only 25 mg/sq m/yr due to low terrestrial export (2.3 mg/sq m/yr) and low precipitation. (Lynch-Wisconsin)
W79-08849

EFFECTS OF ICE COVER ON THE SOLAR RADIATION REGIME IN CANADIAN LAKES,
Department of Fisheries and Environmental, Ottawa (Ontario). Inland Waters Directorate.
W. A. Adams.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 141-149. 8 fig, 1 tab, 21 ref.

Descriptors: *Lakes, *Canada, *Ice cover, *Albedo, *Light penetration, *Solar radiation, *Optical properties, *Oil pollution, *Water pollution effects, *Arctic, Snow cover, Remote sensing, Primary productivity, Oil spills, Attenuation, Cold regions, Measurement, Instrumentation, Research equipment.

Measurement systems for characterizing optical properties of floating ice are described, some results of their use in several Canadian lakes in determining effects on light penetration are presented, and three areas of application are discussed: primary productivity, oil pollution, and remote sensing. The intensity and spectral distribution of solar radiation penetrating an ice-covered lake depends on optical properties (reflectance, scattering, and absorption) of the ice sheet and water column. Geographic location determines radiation quantity through solar elevation and seasonal hours of daylight; climate partially determines stratigraphy and duration of the ice cover. Field studies were carried out in the Mackenzie River delta, Balaena Bay (Northwest Territories) where crude oil was released under sea ice, Lake St. George (Ontario), and near Inuvik, Resolute, and Tuktoyaktuk. Two submersible irradiance meters were used, a diffuse irradiance measurement system and one based on an underwater quanta spectrometer. Calculation of the albedos and percent of solar radiation transmitted through ice showed the albedo to be greatly reduced by a thin film of crude oil. Wet snow or ice had a lower albedo than dry, but the wavelength dependence on moisture content was less clear. A reduction in transmitted light (about 40% greater mean attenuation after oiling) was correlated with primary productivity at 2.5 and 5.0 m below spring sea ice. (Lynch-Wisconsin)
W79-08850

SPATIAL VARIATION IN SIZE AND REPRODUCTIVE CYCLE OF LIMNOCALANOUS MACRURUS IN A DEEP SUBARCTIC LAKE, GREAT SLAVE LAKE,
Fisheries and Marine Service, Winnipeg (Manitoba). Freshwater Inst.
J. Patalas, and K. Patalas.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 150-158. 12 fig, 1 tab, 7 ref.

Descriptors: *Great Slave Lake(Northwest Territories), *Limnocalanus macrurus, *Zooplankton, *Depth, *Spatial distribution, *Reproduction, Cold regions, Water temperature, Water chemistry, Trophic level, Lakes, Canada, Northwest Territories(Canada), Reproduction, Crustaceans, Lake morphometry, Copepods.

Lake morphometry was the most significant factor controlling spatial distribution of the copepod Limnocalanus macrurus in Great Slave Lake, Northwest Territories, Canada. Sampling was conducted July-October 1968 and August 1972. L. macrurus' contribution to the total crustacean community ranged from 1.3% in the North Arm to 62.1% in Christie Bay. Lake depth correlated significantly with density of L. macrurus in the upper 50 m with greatest densities found in deeper stations (Christie Bay 1.7 ind./l and Hearne Channel 0.7 ind/l); with size of mature females (the largest females were found in the shallower part of the lake and the smallest in deep Christie Bay, 614 m); and with mean developmental stages; populations further advanced in development were found in shallower parts of the lake. The smallest animals were found in Christie Bay, larger animals in McLeod Bay, and the largest in the Western Basin. Water temperature did not sufficiently explain L. macrurus distribution. Previous observations show that L. macrurus females extrude eggs directly into the water; they sink to the bottom, and nauplii ascend to the upper trophogenic layers. Due to the depth of Christie Bay nauplii should not appear in the upper zone until long after the end of the reproductive period. In fact, young nauplii were found in the upper 50 m simultaneously with the most intensive reproductive activity, suggesting either that nauplii hatched directly without sinking, or they hatched from eggs produced the year before. (Lynch-Wisconsin)
W79-08851

ZOOBENTHOS OF LAKES LOCATED WITHIN AND OUTSIDE THE ILIMAUSSAQ INTRUSION IN SOUTH GREENLAND,
Copenhagen Univ. (Denmark). Freshwater Biological Lab.
C. Lindegaard, P. Maehl, and B. H. Nielsen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 159-164. 1 fig, 3 tab, 7 ref.

Descriptors: *Benthic fauna, *Ilimaussaq intrusion(Greenland), *Limnology, *Lakes, *Chironomidae, *Geology, *Species composition, Greenland, Ponds, Water chemistry, Bedrock, Baseline studies, Nutrients, Oligotrophy, Pisidium, Oligochaeta, Insects, Diptera, Midges, Altitude, Physicochemical properties, Physical properties, Faunal lists.

Seventeen ponds and lakes in the vicinity of the Ilimaussaq intrusion of South Greenland were investigated in 1975, partly to determine if fauna and flora in the lakes are influenced by unusual chemical features of the area. The intrusion is formed of nepheline syenites with high local concentrations of rare elements, including uranium, thorium, niobium, zirconium, beryllium, and lanthanides. This paper reports on benthic fauna, with a summary of physical and chemical results. Lakes were grouped in three regions, with Regions 1 and 2 within the intrusion, and Region 3 adjacent. Altitudes varied 3-135 m outside the intrusion, and 80-607 m within. The entire area was quite uniform in terms of water chemistry, and lakes were characterized as oligotrophic. Sixteen faunal species were identified (30% of known species in the lakes); Chironomidae dominated with 13 species and comprised 85-100% of total individuals. Oligochaeta and Pisidium sp were found only in small numbers. Faunal density ranged 2700-16,500/sq m in Region 1, 1750-2600/sq m in Region 2, and 0.-4400/sq m in Region 3. All but two of the lakes in Regions 1 and 2 were littoral lakes (transparency > depth), while all but one in Region 3 were profundal (transparency < depth). Differences in density between Regions 1 and 2 may be due to variation density, dependent on bedrock coarseness. Faunal differences can to some extent be ascribed to lake nutrient status and altitude. (Lynch-Wisconsin)
W79-08852

EFFECT OF VOLCANIC ASH DEPOSITS ON SOCKEYE SALMON LAKES,
Washington Univ., Seattle. Coll. of Fisheries.
O. A. Mathisen, and P. H. Poe.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 165-172. 5 fig, 3 tab, 12 ref.

Descriptors: *Sockeye salmon, *Iliamna Lake(AK), *Mount Augustine(AK), *Volcanoes, *Volcanic ash, *Food chains, *Fry, *Spawning, Juvenile fish, Oncorhynchus nerka, Alaska, Kvichak watershed(AK), Lakes, Oligotrophy, Fish, Zooplankton, Cyclops scutifer, Bosmina coregoni, Phytoplankton, Algae, Melosira, Nutrients, Phosphorus, Reproduction, Fish food organisms, Productivity, Limiting factors, Fertilization.

Eruption of the Mount St. Augustine volcano (Cook Inlet, Alaska) in January-February 1976 and deposition of volcanic ash over the Kvichak watershed, including Iliamna Lake, provided an opportunity to study effects of enrichment from the ash on the food chain which includes fry of sockeye salmon (Oncorhynchus nerka). These salmon spawn in many of the major oligotrophic lakes adjoining the North Pacific Ocean. Their food consists of such small zooplankters as Cyclops scutifer and Bosmina coregoni. Zooplankton production is limited by the lakes' normally low dissolved nutrient contents, in turn limiting salmon production. A previous study showed that volcanic eruption caused an immediate increase in diatoms, followed three years later by an eight-fold increase of Cyclops scutifer over the next three years. The Mount St. Augustine 1976 eruptions deposited 6.6-14.9 million metric tons of ash over about 13,000 sq km of the Kvichak watershed, with density in the eastern end ranging 1.1-2.1 kg/sq m. Ash composition included high silica content (63.3% by wt), absence of nitrogen, and higher total phosphorus content (654 ppm) than from carcasses of parent salmon, though only .09 ppm was water-soluble orthophosphate. There was an almost immediate increase of phytoplankton in Iliamna Lake, especially Melosira, but as yet (1976) no change has occurred in total secondary production, or in size or abundance of juvenile sockeye salmon. (Lynch-Wisconsin)
W79-08853

INTERNAL WAVES IN A FJORD LAKE,
Canada Centre for Inland Waters, Burlington (Ontario).
P. F. Hamblin.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 173-181. 7 fig, 1 tab, 5 ref.

Descriptors: *Fjord lakes, *Kamloops Lake(British Columbia-Canada), *Waves(Water), *Water temperature, *Mathematical models, *Internal waves, Lakes, Fjords, British Columbia(Canada), Canada, Thermal stratification, Mixing, Seiches, Isotherms, Model studies, Kelvin waves, Seasonal, Periodicity, Dynamic models.

Simple dynamic models are presented of internal waves observed 1974-75 in Kamloops Lake, an elongated and deep fjord lake in the interior Plateau of British Columbia, Canada, and model results are compared with field observations. Vertical displacements of monitored isotherms can be classified as: (1) motions of amplitudes of 10 m and periods of one hour or less, and (2) waves with amplitudes of 10 m and periods of 40-100 hrs. Well-defined separation between the two is illustrated both by time histories of isotherm displacements and by statistical summaries. A theoretical model for the long-period motions, known as internal Kelvin waves, may account for observed seasonal periodicity trends, despite simplifying assumptions, and the model appears to give accurate estimates for observed periodicities and for relative amplitudes at three lake locations. A model of the radiation of high-frequency internal waves from a uniform region in a stratified fluid accounts for several observed properties of high-frequency internal waves from a uniform region in a stratified fluid accounts for several observed properties of high-frequency waves having a localized source, either near the inflow or in regions of high shear associated with motions induced by the internal Kelvin waves. These processes are extremely important to the formation of lake thermal structure. High-frequency waves and associated mixing may account for relatively uniform temperature gradients in this type of lake, rather than a two-layer stratification. (Lynch-Wisconsin)
W79-08854

LAKES OF CENTRAL ALBERTA WITH EMPHASIS UPON MOOSE LAKE,
Alberta Univ., Edmonton. Dept. of Zoology.
D. N. Gallup.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 182-189. 6 fig, 2 tab, 13 ref.

Descriptors: *Alberta(Canada), *Moose Lake(Alberta-Canada), *Lakes, *Limnology, *Trophic level, *Eutrophication, Canada, Phytoplankton, Algae, Primary productivity, Light penetration, Nutrients, Chlorophyll, Standing crops, Water chemistry, Saline lakes, Morphometry, Depth, Dissolved solids, Water management, Cooking Lake(Alberta-Canada), Cold Lake(Alberta-Canada), Miquelon Lake(Alberta-Canada), Sylvan Lake(Alberta-Canada), Pigeon Lake(Alberta-Canada), Gull Lake(Alberta-Canada), Buffalo Lake(Alberta-Canada).

Eight prairie-parkland lakes near Edmonton, Alberta, Canada were studied 1973-74 to compare water chemistry and primary production to assist lake management efforts and to assess the trophic status of Moose Lake by comparison with the other lakes. Recent massive cyanophyte blooms indicate deteriorating water quality in Moose Lake. Lakes were grouped as saline (Gull, Cooking, Buffalo, and Miquelon Lakes) or freshwater (Moose, Cold, Pigeon, and Sylvan Lakes). Trophic status was best determined by light penetration, standing crop (chlorophyll-a), and primary productivity; the lakes ranged from oligotrophic (Cold Lake) to highly eutrophic (Cooking Lake). Miquelon Lake was the only lake for which nutrient conditions gave better results than the other three parameters, because its high salinity apparently affected phytoplankton growth. Nutrient levels showed it highly eutrophic. Chlorophyll-a values in Moose Lake (2-116 mg/cu m) were well within the eutrophic range, while daily productivity estimates of 0-3150 mg C/sq m/day indicated borderline mesotrophic-eutrophic conditions. In terms of total nitrogen/total phosphate, Moose Lake occupied a low-intermediate position. By chemical water quality, the lakes were (from good to poor): Cold, Pigeon, Sylvan, Moose, Gull, Buffalo, Miquelon, and Cooking. Mean depth (morphometry) and total dissolved solids were rejected as diagnostic parameters since neither showed much relationship to algal productivity. (Lynch-Wisconsin)
W79-08855

MEROMIXIS IN WALDSEA LAKE, SASKATCHEWAN,
Saskatchewan Univ., Saskatoon. Dept. of Biology.
U. T. Hammer, R. C. Haynes, J. R. Lawrence, and M. C. Swift.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 192-200. 3 fig, 16 ref.

Descriptors: *Waldsea Lake(Saskatchewan-Canada), *Meromixis, *Saline lakes, *Water temperature, *Stratification, Saskatchewan(Canada), Lakes, Conductivity, Ice cover, Thermal stratification, Cold regions, Monimolimnion, Chemocline, Mixolimnion, Mesothermy, Shallow water, Winds, Depth, Anaerobic conditions, Salinity, Mixing.

Waldsea Lake, one of two known meomictic lakes in Saskartchewan, Canada, was first reported in 1971; this paper reports on its thermal and salinity regime based on 1970-77 studies. Meromictic lakes are those uncommon lakes which do not mix completely during one year. The lowest layer, usually more saline and anoxic than the other two, is the monolimnion, separated from the upper, fully circulating mixolimnion by the intermediate chemocline. Dichothermy, mesothermy, and poikilothermy are abnormal thermal stratifications common to meromictic lakes. Waldsea Lake is unlikely to maintain meromixis, since compared to other such lakes, it is large (4.64 sq km surface area), shallow (maximum depth 14.3 m, mean depth 8.1 m), unprotected from winds, and its ratio of monimolimnion salinity to mixolimnion salinity is relatively low, ranging from 1.88 in 1971 to 2.65 in 1972 (August). Waldsea Lake is therefore chemically less stable than most other meromictic lakes, such as Soap Lake (Washington) with a ratio of nine. Waldsea Lake is fed by four minor temporary streams, but has not outlet. Mesothermy (middle-layer maximum temperature) is characteristic of the lake from after mid-August until the ice cover is established. The lake tends to follow the temperature sequence of a typical temperature dimictic lake, but only in the mixolimnion. The variable location of the three layers over the course of the study period is discussed. (Lynch-Wisconsin)
W79-08856

CONTRIBUTION OF PHOTOSYNTHETIC GREEN SULPHUR BACTERIA TO TOTAL PRIMARY PRODUCTION IN A MEROMICTIC SALINE LAKE,
Saskatchewan Univ., Saskatoon. Dept. of Biology.
J. R. Lawrence, R. C. Haynes, and U. T. Hammer.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 201-207. 4 fig, 20 ref.

Descriptors: *Meromixis, *Waldsea Lake(Saskatchewan-Canada), *Photosynthetic bacteria, *Primary productivity, *Saline lakes, *Stratification, *Photosynthesis, Sulfur bacteria, Bacteria, Saskatchewan(Canada), Canada, Lakes, Limnology, Carbon radioisotopes, Hydrography, Mixolimnion, Salinity, Chlorobium, Carbon fixation, Light penetration, Chlorobacteriaceae, Seasonal, Anaerobic conditions, Food webs.

Annual production of green sulfur bacteria (Chlorobacteriaceae) in saline, meromictic Waldsea Lake (Saskatchewan, Canada) is 46% of total primary productivity in the lake, based on studies in 1976-77. Maximum productivity of the bacteria is 1320 mg C/cu m/day (398 mg C/sq m/day), and annual production is estimated at 32 g C/sq m/yr. Phytoplankton productivity is 345 mg C/sq m/day, and annual production estimated at 38 g C/sq m/yr. Bacterial production is higher than previously thought, and may constitute an important base of food webs in some lake systems. In meromictic Waldsea Lake, total ion content of the monimolimnion (the lowest of the three strata) is 2.25 times greater than in the upper mixolimnion. The intervening chemocline thus exhibits steep physical and chemical gradients. The bacterial plate, dominated by Chlorobium, is located in a narrow 30-cm stratum at the interface of the chemocline and monimolimnion. No more than 5% of incident radiation, corrected for reflection, reaches the plate, and only 1% typically reaches the center of the plate where a massive population of Chlorobacteriaceae persists throughout the year. Growth conditions for these bacteria combine anaerobia, low electrode potential, medium to high pH, H2S, and light. Chlorobium principally contains BChl-d and accessory pigments, up to 2325 microg/l. Photosynthetic activity is intense in mid-summer with an unexplained depression in mid-July, but subsequently there is little net productivity despite high BChl-d levels. (Lynch-Wisconsin)
W79-08857

COLLAPSES OF APHANIZOMENON FLOS-AQUAE BLOOMS RESULTING IN MASSIVE FISH KILLS IN EUTROPHIC LAKES: EFFECT OF WEATHER,
Fisheries and Marine Service, Winnipeg (Manitoba). Freshwater Inst.

J. Barica.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 208-213. 4 fig, 7 ref.

Descriptors: *Fishkill, *Aphanizomenon flos-aquae, *Eutrophication, *Collapse, *Oxygen depletion, *Light intensity, *Weather, *Manitoba(Canada), Air temperature, Water temperature, Cloud cover, Nutrient loading, Canada, Pothole lakes, Summerkill, Dissolved oxygen, Algae, Phytoplankton, Cyanophyta, Lakes, Chlorophyll, Biomass, Microcystis, Anabaena, Winds, Runoff, Solar radiation, Prairie Lakes.

Twenty-six partial or total algal collapses (1971-76) in three shallow, eutrophic, summerkill prairie lakes in the Erickson-Elphinstone area of southwestern Manitoba, Canada, were triggered by a sudden drop in light intensity resulting from overcast conditions. A concomitant (but sometimes delayed) drop in water temperature associated with the collapses was probably due to the overcast conditions as well. Fish mortality was caused only by blooms of Aphanizomenon flos-aquae; mixed blooms of Microcystis, Anabaena, and Aphanizomenon did not develop sufficiently extreme biomass levels. Probability and severity of summerkill depends on magnitude and duration of oxygen depletion, dependent in turn on maximum algal biomass. The three lakes (Lakes 885, 154, and 882) substantiated 100 microg/l chlorophyll-a as the dividing line between low and high summerkill risk, with exception of a 1975 bloom in Lake 885 which collapsed after reaching 80 microg/l. Biomass fluctuations are apparently controlled by nutrient loading, and therefore hydrologic and weather conditions during winter and spring runoff may strongly affect biomass levels. In advanced stages of bloom development an acute phosphorus deficiency occurs, resulting in yellowing and clumping of algae, and turbidity. Warm, sunny weather can maintain a bloom even under such nutrient-deficient conditions, but a sudden drop in light intensity or water temperature (or both) causes the bloom to collapse. (Lynch-Wisconsin)
W79-08858

REHABILITATION OF EUTROPHIC PRAIRIE LAKES IN CANADA,
Fisheries and Marine Service, Winnipeg (Manitoba). Freshwater Inst.
R. J. Allan, and B. C. Kenney.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 214-224. 4 fig, 3 tab, 27 ref.

Descriptors: *Lake restoration, *Qu'Appelle Basin(Canada), *Eutrophication, *Model studies, *Phosphorus, *Nutrient loading, *Runoff, Trophic level, Vollenweider models, Canada, Prairie lakes, Fishing Lakes(Canada), Pasqua Lake(Canada), Echo Lake(Canada), Mission Lake(Canada), Katepwa Lake(Canada), Lakes, Flushing rate, Chlorophyll, Hydraulic residence time, Spring, Ice cover, Forecasting, Algae, Phytoplankton, Primary productivity, Baseline studies, Tertiary treatment.

Data was compiled to document the status of the eutrophic Fishing Lakes (Pasqua, Echo, Mission, and Katepwa) in the Qu'Appelle Basin of south-central Canada prior to initiation in 1977 of tertiary sewage treatment in the town of Regina, which with Moose Jaw contributes some 50% of phosphorus inputs to the basin. A data collection program begun in 1976-77 will monitor improvements expected in the lakes. Calculation of annual phosphorus loading confirmed the lakes are an extreme case, with levels far exceeding many other lakes reported in the literature. Loadings with highest (up to 25 g/sq m) in years of medium and high spring runoff, compared with 3.3 g/sq m in low-runoff years. Application of recent models show trophic level is lowest in years of high spring runoff, and artificial spring flushing could help reduce phosphorus loading and further lower trophic level. Spring runoff also flushes phosphorus regenerated under winter ice. In drought years late winter total phosphorus concentrations up to 600 mg/cu m extend into spring, while in flood years levels are drastically reduced. Chlorophyll-a concentrations are very high in low-flow years and much lower in high-runoff years; concentrations are accurately predicted by Vollenweider's loading parameter, implying that reduction in phosphorus loading will result in reduced productivity. However, prediction of chlorophyll-a levels from phosphorus data overestimate measured values, possibly related to the very low spring total nitrogen/total phosphorus ratios in low-runoff years. (Lynch-Wisconsin)
W79-08859

PRODUCTION OF CLADOCERA INHABITING THE VEGETATED LITTORAL OF PINEHURST LAKE, ONTARIO, CANADA,
Malaya Univ., Kuala Lumpur (Malaysia). Dept. of Zoology.
R. P. Lim, and C. H. Fernando.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 225-231. 2 fig, 4 tab, 23 ref.

Descriptors: *Cladocera, *Littoral, *Limnetic zone, *Pinehurst Lake(Ontario-Canada), *Productivity, *Zooplankton, Ceriodaphnia quadrangula, Bosmina longirostris, Echinisca rosea, Acroperus harpae, Alonella exigua, Chydorus sphaericus, Ontario(Canada), Canada, Lakes, Growth rates, Growth stages, Water temperature.

In 1974-75 in small, shallow Pinehurst Lake (Ontario, Canada), overall cladoceran production in the vegetated littoral exceeded production in the limnetic zone; this is attributed to the greater diversity of habitats in the littoral, able to support a greater diversity and hence greater density of cladocerans. The six dominant species belong to six different genera: Ceriodaphnia quadrangula, Bosmina longirostris, Echinisca rosea, Acroperus harpae, Alonella exiguna, and Chydorus sphaericus. Both floristic and faunistic complexity can be considered responsible for the higher productivity of the littoral. Eurytopic species (Ceriodaphnia, Bosmina, and Chydorus) had higher daily production rates than species restricted to the littoral, though Chydorus' production rate in the limnetic zone was low and it was not dominant there. Daily production rates of Ceriodaphnia and Bosmina did not differ significantly between littoral and limnetic zone, except for Bosmina in 1975 when its littoral production was twice that of its limnetic production. Higher overall littoral production was due primarily to the combined contribution of the six dominant species, plus that of the other 32 species of the littoral. Within the littoral, Ceriodaphnia had the highest production in 1974 (16.61 mg dry wt/10 liters), and Bosmina the highest in 1975 (62.62 mg dry wt/10 liters). Total production for the six dominant littoral species was 67.31 mg/10 liters in 1974 and 139.20 mg/10 liters in 1975, and for the three present in the limnetic zone it was 27.71 mg in 1974 and 63.78 mg in 1975. (Lynch-Wisconsin)
W79-08860

NOTES ON ZOOPLANKTON FROM SOME LABRADOR LAKES,
Memorial Univ. of Newfoundland, St. Johns's. Dept. of Biology.
C. C. Davis.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 233-239. 2 fig, 3 tab, 14 ref.

Descriptors: *Labrador(Canada), *Smallwood Reservoir(Newfoundland-Canada), *Ten Mile Lake(Newfoundland-Canada), *Species composition, *Abundance, *Kaipokok-Makkovik-Big River region(Newfoundland-Canada), *Zooplankton, Lakes, Ponds, Reservoirs, Copepods, Cladocera, Newfoundland(Canada), Dominant organisms, Daphnia longiremis, Daphnia pulex, Bosmina coregoni, Holopedium gibberum, Cyclops scutifer, Diaptomus minutus, Daphnia galeata mendotae.

Zooplankton were surveyed in two areas of Labrador (Newfoundland, Canada): (1) 5700-sq km Smallwood Reservoir and adjacent Ten Mile Lake, sampled June-August 1974; and (2) the Kaipokok Bay-Makkovik Bay-Big River region (18 lake, pond, and stream sites sampled August 1975). Recent formation of the reservoir flooded extensive areas of uncleared forest and bog, and joined together several lakes and ponds. Results for Smallwood Reservoir indicate increased abundance of five of the seven most important crustaceans, compared to a 1975 report (Bosmina coregoni, Daphnia longiremis, D. pulex, Holopedium gibberum, and Cyclops scutifer); exceptions were Diaptomus minutus. Daphnia galeata mendotae, and in the Lobstick section D. pulex. Total quantity of zooplankton in the southern Michikamau section greatly increased, with an overwhelming shift in dominance from copepods to cladocerans; the earlier report gave a three-year maximum of only 483/cu m for D. longiremis, compared with 11,021/cu m in this study, while D. pulex increased 0-1159/cu m and B. coregoni from 782/cu m to 2321/ccu m. In the Daipokok-Makkovic-Big River area copepods generally dominated. The only diaptomid was the ubiquitous northern species Diaptomus minutus. Adult cyclopoids were notably subordinate, and rotifers were far less important than in Smallwood Reservoirs or Ten Mile Lake. D. longiremis was the only Daphnia species encountered, except for D. dubia in a single locality. (Lynch-Wisconsin)
W79-08861

DISTRIBUTION OF BENTHIC MACROINVERTEBRATE COMMUNITIES IN LAKE ERIE'S EASTERN BASIN,
Texas Univ. at Austin, Port Aransas. Port Aransas Marine Lab.
R. W. Flint, and C. N. Merckel.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 240-251. 7 fig, 1 tab, 12 ref.

Descriptors: *Lake Erie, *Invertebrates, *Benthic fauna, *Biological communities, *Habitats, *Distribution, *Eastern basin(Lake Erie), *Great Lakes, Lakes, Water pollution effects, Eutrophication, Sediments, Bioindicators, Faunal lists, Tubificids, Amphipoda, Sphaeriidae, Ecology, Ecosystems, Peloscolex, Sphaerium corneum, Aulodrilus, Stylodrilus heringianus, Mononchus, Potamothrix moldaviensis, Bithinia tentaculata, Limnodrilus hoffmeisteri, Pontoporeia affinis, Tubifex tubifex, Density.

Changes in the benthic environment of the comparatively oligotrophic eastern basin of Lake Erie are described in terms of the type of macroinvertebrate community and its structural changes during 1973-76. Chemical and physical gradients in bottom sediments and habitat determined community distribution. Since community variations were a function of geographical location rather than season, the 11 community types identified remained relatively stable over the four years of the study. Although symptoms of eutrophication have begun to appear in the basin, no anoxia occurred during the study period, and oxygen conditions probably were not a major distributional influence. Communities are identified by a characterizing species: (1) Peloscolex ferox, (2) Sphaerium corneum, (3) Peloscolex multisetosus, (4) Aulodrilus pleureseta, (5) Aulodrilus americanus, (6) Potamothrix modlaviensis, (7) Stylodrilus heringianus, (8) Mononchus sp, (9) Bithinia tentaculata, (10) Limnodrilus hoffmeisteri-Pontoporeia affinis, and (11) Tubifex tubifex. For each community a list of additional characterizing fauna is given. The eastern, shallow-water Aulodrilus pleuriseta community was considered transitional between the eastern, shallow-water Peloscolex community and the central, deeper Limnodrilus-Pontoporeia community, based on the composition of associated fauna. Sediment carbon content, soil texture, and sediment disturbances affected community type. (Lynch-Wisconsin)

W79-08862

PRODUCTION OF ZOOPLANKTON AT NEARSHORE STATIONS IN LAKES ONTARIO AND ERIE,
Ohio State Univ., Columbus. Dept. of Zoology.
D. A. Culver, and W. R. DeMott.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 252-256. 2 fig, 16 ref. U.S. Department of Interior, OWRT A048-Ohio.

Descriptors: *Zooplankton, *Productivity, *Nearshore zone, *Lake Ontario, *Lake Erie, *Biomass, *Water temperature, *Estimating equations, Bay of Quinte(Lake Ontario), Great Lakes, Lakes, Abundance, Size, Equations, Cladocera, Growth stages, Instars, Length, Seasonal, Summer, Methodology, Hydraulic residence time, Flushing rate, Computer programs.

A computer program was used to calculate nearshore zooplankton production estimates for one station (four m depth) in Lake Ontario's Bay of Quinte, and from 10 closely spaced stations (2.3-4.9 m depth) in Lake Erie's western basin. Lake Ontario samples were collected weekly during summer 1974, and Lake Erie samples monthly April 1975-March 1976. Vertical temperatures were assumed homogeneous at any one time and station. Productivity was calculated from: (1) abundance, (2) biomass, and (3) temperature-dependent developmental rates. The productivity equation is provided. Values were necessary for each instar or size class for each species. Bay of Quinte zooplankton biomass was strongly correlated with temperature; maximum weight coincided with high temperatures during clear, calm weather. With mean residence time of 0.07 years, flushing of the bay by river water was important. Unlike the mid-summer depression of numbers observed in many systems, biomass oscillated between the high and low values throughout the summer. In western Lake Erie both biomass and production exceeded that of the Bay of Quinte. A midsummer decline occurred, but the subsequent numerical increase in September-October was not reflected in a corresponding increase in productivity. Average productivity/biomass (P/B) ratios were comparable for the two sites (about 0.182 for Lake Ontario and 0.2 for Lake Erie), implying complete biomass turnover every five days in summer. Average P/B ratio was a poor estimate of the daily ratio, however, due to great variations. (Lynch-Wisconsin)
W79-08863

PHOTOSYNTHESIS, EXTRACELLULAR RELEASE AND GLYCOLLIC ACID UPTAKE BY PLANKTON: FRACTIONATION STUDIES,
Scarborough Coll., Toronto. Div. of Life Science.
K. Lee, and C. Nalewajko.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 257-262. 4 fig, 1 tab, 26 ref.

Descriptors: *Glycollic acid, *Phytoplankton, *Photosynthesis, *Size, *Lake Erie, *Lake Ontario, *Great Lakes, Primary productivity, Fractionation, Absorption, Bacteria, Diatoms, Chrysophyta, Chlorophyta, Cyanophyta, Lakes, Rhodomonas, Uroglenopsis americana, Scenedesmus bijuga, Tracers, Carbon fixation, Organic matter, Algae, Carbon radioisotopes.

Specific organisms responsible for primary production, extracellular release, and glycollic acid uptake based on size fractionation were studied with samples from Lakes Ontario and Erie (western basin) in summer 1976. Rhodomonas sp. was responsible for the highest photosynthetic rates. Extracellular release rates were highest in the phytoflagellates Rhodomonas sp. and Ureglenopsis americana, and in the chlorophyte Scenedesmus bijuga. Glycollic acid uptake was correlated with bacteria. Absolute amounts of soluble organic material released by photosynthetic algae in the two lakes was relatively small (less than 5%). Glycollic acid concentrations were 58 microg/l in Lake Erie and 24 microg/l in Lake Ontario. Several studies have indicated that up to 50% of total carbon fixed in the photic zone may be liberated into the water in soluble organic form; extracellular products could be significant as metabolites and energy sources for microorganisms. Filters of various pore sizes were used to fractionate natural populations prior to tracer additions. Photosynthesis, extracellular release, and carbon-14/glycollic acid uptake were linear in the tests. In Lake Ontario 79% of photosynthesis and 80% of algal biomass were in the size ranges 3-8 and above 70 micrometers (combined), dominated by the diatoms Asterionella formosa, Synedra ulna, and Stephanodiscus sp. In Lake Erie 89% of photosynthesis and 61% of biomass were in the 3-8 and 8-30 micrometer classes, dominated by the cyanophyta Aphanizomenon flos-aquae and Ababaena affinis. (Lynch-Wisconsin)
W79-08864

PHOSPHORUS REMOVAL AT GRAVENHURST BAY, ONTARIO: AN 8 YEAR STUDY ON WATER QUALITY CHANGES,
Ontario Ministry of the Environment, Rexdale.
P. J. Dillon, K. H. Nicholls, and G. W. Robinson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 263-271. 6 fig, 4 tab, 28 ref.

Descriptors: *Phosphorus, *Nutrient removal, *Sewage treatment, *Gravenhurst Bay(Ontario-Canada), *Eutrophication, *Phytoplankton, *Lake restoration, *Lake Muskoka(Ontario-Canada), Mathematical models, Nutrients, Nutrient budgets, Algae, Cyanophyta, Aphanizomenon, Ababaena, Microcystis, Biomass, Chlorophyll, Oxygen depletion, Water pollution control, Ontario(Canada), Canada, Species composition, Nitrogen, Model studies, Forecasting, Bays.

Phosphorus removal begun in 1971 for sewage effluents discharged into Gravenhurst Bay, an isolated portion of Lake Muskoka in southern Ontario, Canada, resulted in rapid improvement of water quality, which prior to 1972 had been characterized by severe algal blooms, poor clarity, and virtual absence of hypolimnetic oxygen. Phosphorus was reduced 55% from an average 44 mg/cu m 1969-71 to 20 mg/cu m in 1975, a level near that predicted by a nutrient budget model. Average chlorophyll-a concentration and algal biomass were halved (chlorophyll-a from an average of 9.8 mg/cu m to 5.0, and biomass from an average 2340 ASU/ml to 1120). There was a drastic reduction in the bloom-forming cyanophytes Aphanizomenon, Anabaena, and Microcystis from 33% of total biomass prior to removal to 15% by 1975. In late 1975 a second treatment plant began operation to accomodate the increasing population of the town of Gravenhurst, with half the municipal sewage output diverted through the new plant. However, chemical phosphorus removal with iron chloride proved inefficient (only 40% removal vs 90% at the old plant), and water quality deteriorated quickly, with an Aphanizomenon bloom climaxing at 43,000 ASU/ml. Correction of the technical difficulties resulted in reversal of the deterioration within three months, and conditions of low algal biomass and a species composition typical of oligotrophic Precambrian Shield lakes returned. (Lynch-Wisconsin)
W79-08865

AN INTRODUCTION TO THE INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES,
Atmospheric Environment Service, Downsview (Ontario).
T. L. Richards.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 272-275.

Descriptors: *International Field Year for the Great Lakes(IFYGL), *Great Lakes, *Lake Ontario, *International cooperation, *Planning, *Basic data collections, *Water management(Applied), United States, Canada, International commissions, Lakes, Water conservation, Natural resources, Resource management, Water quality control, International Hydrological Decade, United Nations, UNESCO, Research facilities, Scientific personnel, History.

An overview of the planning and operation of the 1972-73 International Field Year for the Great Lakes (IFYGL) also introduces a symposium on IFYGL presented at the 1977 Congress of the International Association of Theoretical and Applied Limnology. Intensive data collection was undertaken April 1972-March 1973, with some projects extended to July 1973. Lake Ontario was selected as the study lake. All verified data are now in the Canadian and U.S. IFYGL data banks, final catalogues have been published or are in press, interim project status reports and more than 250 scientific papers have been published, and a detailed final overview is planned. The program originated about 1965 with growing awareness that a concentrated international and interdisciplinary study was necessary to ensure preservation of the lakes, recognized as an important natural resource to both countries. Sponsorship of IFYGL by UNESCO's International Hydrological Decade was proposed in 1965, and a steering committee was organized. A workshop was held in 1967, the IFYGL concept was endorsed by 70 scientists, and a formal policy statement was issued in April. Four scientific advisory working groups were set up to identify the most critical problems and later to asses the technical suitability of proposed projects; they also prepared a list of new facilities required. Funding was provided by several public and private agencies and groups in the two countries, particularly NOAA in the U.S. Over 150 projects were undetaken. (Lynch-Wisconsin)
W79-08866

HYDROLOGY OF LAKE ONTARIO,
Environmental Management Service, Cornwall (Ontario).
D. F. Witherspoon.
In: Proceedings: 20th Congress, International Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 276-279. 3 tab.

Descriptors: *Internationale Field Year for the Great Lakes(IFYGL), *Lake Ontario, *Hydrology, *Water balance, *Evaporation, *Great Lakes, Lakes, Equations, Estimating equations, Water management(Applied), Water level fluctuations, Inflow, Outflow, Precipitation(Atmospheric), Runoff, Groundwater, United States, Canada, International commissions.

Lake Ontario water balance was investigated as part of the International Field Year for the Great Lakes (IFYGL). Water balance results are needed for estimating evaporation. A water balance equation summarizes the hydrology of the lake, incorporating inflow from Lake Erie (I), outflow via the St. Lawrence River (0), water surface precipitation (P), runoff into the lake (R sub L), groundwater flow from the shores of the lake (G sub L), and the change in the lake (delta S). The equation is: water surface evaporation (E) = I- O + P + R sub L + G sub L + or - delta S. A table presents monthly variations in these parameters for April 1972-March 1973. Despite Lake Ontario's large size, its local basin has a relatively small effect on its water supply because of the large volume of flow through it. Local hydrology is the principal cause of water level fluctuations. Large-volume inflows and outflows must be measured with great precision or relatively large errors may result in evaporation estimates from water balance in spring and early summer. When the storage change was positive (April-June), the lake level rose as inflow exceeded outflow; these were also months of higher local runoff. When the storage change was negative (July-October) lake level fell and outflow exceeded inflow; these months corresponded to low runoff and increased evaporation. As lake level increases, outflow also increases. (Lynch-Wisconsin)
W79-08867

INTERNAL WAVES AND ASSOCIATED CURRENTS IN LAKE ONTARIO OBSERVED DURING THE IFYGL PROGRAM,
Wisconsin Univ.-Milwaukee. Center for Great Lakes Studies.
C. H. Mortimer.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 280-287. 2 fig, 37 ref.

Descriptors: *Lake Ontario, *Internationale Field Year for the Great Lakes(IFYGL), *Internal waves, Water temperature, Air-water interfaces, Winds, Waves(Water), Inertia, Inland seas, Gulfs, Model studies, United States, Canada, International commissions.

Water motions and air-water interactions in Lake Ontario were studied through physical measurements and modelling during the International Field Year of the Great Lakes (IFYGL); this paper reviews results from 1972 for the periods of stratification development (May-June) and full stratification (July-November). Numerous independent measurements confirmed that patterns of water motion display a wide range of forms, origins, and scales, and are strongly and characteristically influenced by lateral boundaries, earth rotation, and presence or absence of a seasonal thermocline. These findings match those for other large lakes, gulfs, and land-locked seas. The motions fall into two groups: (1) episodic oscillatory responses to wind impulses (the focus of this paper), and (2) steadier responses in the form of mean circulation patterns. Conceptual modelling of the first group based on Ekman's description is summarized, as are models of the Kelvin and Poincare wave types. A principal discovery during IFYGL was the demonstration in Lake Ontario that inertial motion in enclosed seas is generated intermittently by the combined influence of the immediate Ekman response at inertial frequency to impulsive wind stress in open waters, and the subsequent Poincare responses (resonant excitation of one or more modes with near-inertial frequencies) set in motion by pressure gradients arising from wind-induced distortiones of the nearshore thermocline interface. (Lynch-Wisconsin)
W79-08868

IFYGL CIRCULATION MODELLING AT CCIW,
Canada Centre for Inland Waters, Burlington (Ontario).
T. J. Simons.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 288-294. 3 fig, 17 ref.

Descriptors: *Lake Ontario, *International Field Year for the Great Lakes(IFYGL), *Mathematical models, *Circulation, *Lakes, *Great Lakes, Model studies, Numerical analysis, Hurricanes, Hurricane Agnes, Simulation studies, Water levels, Currents(Water), Water temperature, Winds, Stratification, Hydrology, Wind stress, Bottom drag, Heat diffusivity, Vertical eddy viscosity, United States, Canada, International commissions.

A model based on the framework established by numerical weather prediction and storm surge forecasting was developed by the Canada Centre for Inland Waters (CCIW) during the International Field Year for the Great Lakes (IFYGL) for use on large lakes (such as Lake Ontario) in computing water levels, currents, temperatures, and transport of dissolved or suspended materials. The project involved three phases: (1) survey of numerical techniques used in geophysical fluid dynamics studies, and model development; (2) verification with IFYGL data for two periods of atmospheric stress (June 1972, tropical storm Agnes, when the lake was weakly stratified, and August 1972 at the peak of stratification); and (3) long-term simulations of the physical environment and interactions with biochemical processes. Physical variables of the model are horizontal and vertical water motions, surface elevations, and temperatures, which are distributed on a staggered grid in space and time. Several other parameters represent small-scale quasi-random motions which cannot be treated by deterministic methods, including coefficients of surface wind stress and bottom drag, and vertical eddy viscosity and heat diffusivity between model layers. The model was run for the complete 1972 field year. Use of the dynamic model with plankton models resulted in realistic simulations of such essential phenomena as time lag between nearshore and deep water algal blooms in spring, and effects of upwelling and overturning during the stormy fall season. (Lynch-Wisconsin)
W79-08869

ATMOSPHERIC BOUNDRY LAYER - IFYGL,
Canada Centre for Inland Waters, Burlington (Ontario).
F. C. Elder.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977, Vol. 20, September 1978, Part 1, p 295-303. 9 fig, 15 ref.

Descriptors: *Lake Ontario, *International Field Year for the Great Lakes(IFYGL), *Atmospheric boundary layers, *Heat transfer, *Meteorological data, *Winds, *Great Lakes, Lakes, Boundary layers, Atmosphere, Eddies, Wind drag, Air temperature, Humidity, Wind velocity, Evaporation, Air-water interfaces, Circulation, Mixing, Thermal stratification, Heat budget, Energy, Heat, United States, Canada, International commissions.

The atmospheric boundary layer segment of the International Field Year for the Great Lakes (IFYGL)--concentrated on Lake Ontario--was designed to: (1) determine lake-air fluxes of heat, water vapor, momentum, and trace substances (such as sulfur dioxide), and the distribution and variability of those fluxes in space and time; (2) develop improved methods of estimating lake-air fluxes primarily using routinely available observations; and (3) produce an observational data set for testing theoretical and numerical models of the behavior of the boundary layer over the lake and its interactions with large-scale atmospheric processes and with lake circulation. The program produced an excellent file of experimental data on both micro- and mesoscale meterological fields; improved estimates of the surface energy fluxes were obtained suitable for deriving the lake's energy budget and for correlation with lake physical, chemical, and biological events. Data generally agreed with existing hypotheses, though boundary layer profiles departed significantly from overland characteristics. Atmospheric boundary layers processes interact intimately with chemical and biological lake processes: (1) the turbulent eddies of the boundary layer acting at the lake's surface determine air-water transfers of water and latent heat in evaporation and the vertical transfer of sensible heat; (2) these eddies determine heating or cooling of surface layers, and the resulting thermal structure plus surface wind stress determine lake circulation and mixing. (Lynch-Wisconsin)
W79-08870

BIOLOGY-CHEMISTRY PROGRAM DURING IFYGL,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
N. A. Thomas, T. F. Nalepa, and A. Robertson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 304-310. 2 fig, 1 tab, 12 ref.

Descriptors: *International Field Year for the Great Lakes(IFYGL), *Biology, *Water chemistry, *Trophic level, *Eutrophication, *Lake Ontario, *Ecology, *Great Lakes, International commissions, United States, Canada, Lakes, Ecosystems, Bioindicators, Benthic fauna, Invertebrates, Phytoplankton, Algae, Zooplankton, Cladophora, Nutrients, Recycling, Mesotrophy, Oligotrophy, Sediments, Phosphorus, Limiting factors, Primary productivity, Succession, Seasonal, Limnodrilus hoffmeisteri, Tubifex tubifex, Stylodrilus heringianus, Water pollution effects, Water pollution sources.

Studies to characterize biological and chemical parameters of Lake Ontario during the International Field Year for the Great Lakes (IFYGL) in 1972-73 are summarized. Goals were to: (1) determine the lake's trophic status and identify problem areas, (2) describe important ecological processes, and (3) generate data for developing and verifying mathematical models. Indicator species of benthic invertebrates provided the best means of evaluating trophic levels. The eutrophic indicator species Limnodrilus hoffmeisteri and Tubifex tubifex were found in great abundance near urban areas, with the most obvious eutrophication near the mouth of the Niagara River and in the Toronto vicinity. Mesotrophic conditions were evident along the southern shore from the Niagara River to Rochester. Sylodrilus heringianus and Pontoporeia affinis were used as indicators of oligotrophy; the former dominated much of the central and north-central part of the lake. Budgets were calculated for various lake chemicals, and those for nitrogen, phosphorus, and chloride are presented. Sediment phosphorus contribution to lake water was about 10% of phosphorus loading from external sources. Both nitrogen and phosphorus limited primary productivity. The latter was much too high relative to measured nutrient depletion, and recycling is thought to have accounted for 87% of phosphorus and 69% of nitrogen uptake by phytoplankton. Phytoplankton species composition was typical of eutrophic waters, including great numbers of Stephanodiscus. (Lynch-Wisconsin)
W79-08871

ECOSYSTEM AND WATER QUALITY MODELING DURING IFYGL,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
A. Robertson, and D. Scavia.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, 311-316. 5 fig, 1 tab, 7 ref.

Descriptors: *International Field Year for the Great Lakes(IFYGL), *Lake Ontario, *Mathematical models, *Ecostems, *Chemical properties, *Biological properties, *Great Lakes, Lakes, Model studies, Nutrients, Cycling nutrients, Carbon cycle, Algae, Phytoplankton, Zooplankton, Ecology, Resource management, Water management(Applied), Seasonal, Limiting factors, Benthic fauna, Invertebrates, Turnovers, Canada, United States, International commissions.

Various ecological models developed during the International Field Year for the Great Lakes (IFYGL) 1972-73, based on data from Lake Ontario, differ in detail but have basically the same framework and function in essentially the same manner. This paper describes the model developed at the Great Lakes Environmental Research Laboratory (GLERL), which simulates dynamics of a number of chemical and biological properties of Lake Ontario. It is composed of a series of differential equations describing dynamics of five phytoplankton and six zooplankton types, detritus, organic nitrogen, ammonia, nitrate, available phosphorus, silica, oxygen, the carbonate system, and benthic invertebrates. The model uses inputs of temperature, turbulent diffusivity, solar radiation, and length of photoperiod, obtained from actual measurements or by calculations based on theory. The differential equations are solved with a time step of one day to observe seasonal cycles of model compartments; this has been done for two and three vertical layers of the lake. Calculated values for sedimentation and diffusion provided estimates of exchange between layers. Spatial subdivision can be increased in the vertical or expanded into the horizontal (if horizontal water movements can be estimated). The models can: (1) estimate carbon flow among trophic compartments, (2) estimate turnover times, (3) determine factors controlling productivity, and affecting nutrient dynamics, and (4) assist in resource management. (Lynch-Wisconsin)

W79-08872

RELEVANCE OF IFYGL,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
E. J. Aubert.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 317-323. 4 fig, 15 ref.

Descriptors: *International Field Year for the Great Lakes(IFYGL), *Lake Ontario, *Limnology, *Hydrology, *Water balance, *Basic data collections, *Great Lakes, Meteorology, Lakes, International cooperation, Monitoring, Evaporation, Model studies, Mathematical models, Water management(Applied), Circulation, Waves(Water), Algae, Phytoplankton, Zooplankton, Benthic fauna, Primary productivity, Internal waves, Species composition, Distribution, Abundance, Water quality, Canada, United States, International commissions.

The International Field Year for the Great Lakes (IFYGL), an experimental and theoretical research program focusing on the limnology, hydrology, and meteorology of Lake Ontario and its basin, involved scientists, engineers, and technicians from Canada and the U.S. Data was collected 1972-73. Water quantity projects dealt with the process and prediction of lake evaporation; water quality investigations were on limnological mechanisms, phenomena, and predictive and simulation modelling, and included water movements, thermal structure, nutrients, water chemistry, plankton, benthos, fish, and lake-air interactions. Effects of both natural processes and man's activities were encompassed. Results of water quantity studies: (1) the seasonal evaporation cycle was characterized by a relatively smooth and rapid transition, with a pronounced maximum September-February, and a minimum May-June; (2) the drag coefficient was dependent upon atmospheric stability; and (3) an energy balance was constructed. Water quality results: (1) for mid-lake mean calculation, a one-cell cyclonic gyre was typical of the warm season, but a two-cell counterrotating circulation also occurred, with the preference dependent upon relative magnitude of the surface wind curl and bottom shape effects; (2) intertial and near-inertial Poincare waves predominated in mid-lake, while longer-period Kelvin and topographic waves predominated within 12 km from shore; and (3) the species composition, abundance, and distribution of fauna and flora in space and time were determined. (Lynch-Wisconsin)
W79-08873

THE INFLUENCE OF PLANKTONIC AND BENTHIC CRUSTACEANS ON SILICON CYCLING IN LAKE MICHIGAN, U.S.A.,
Argonne National Lab., IL. Environmental Impacts Studies Div.
J. G. Ferrante, and J. I. Parker.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 324-328. 3 fig, 1 tab, 8 ref.

Descriptors: *Lake Michigan, *Cycling nutrients, *Silicon, *Crustaceans, *Diatoms, *Copepods, *Mysis relicta, *Boundary layers, Benthic fauna, Amphipoda, Pontoporeia affinis, Sedimentation, Sediments, Frustules, Fecal pellets, Great Lakes, Lakes, Zooplankton, Phytoplankton, Eutrophication, Chrysophyta, Grazing, Sediment-water interfaces.

Calanoid copepod and Mysis relicta fecal pellets are important in Lake Michigan for transporting fragmented diatom frustules, the major source of reactive silicon (rSi) needed for diatom production, through the metalimnion where dissolution results in accumulation of rSi in the upper hypolimnion. The rSi is effectively retained there by the metalimnion. In late summer-early fall depression of the metalimnion results in mixing of rSi-rich hypolimnetic water into the epilimnion, eventually triggering the fall diatom bloom. The increase in rSi near the sediment-water interface, shown by Conway, et al (1977), suggests a process in which amorphous silicon (aSi) is converted to rSi, possibly as the result of activity by the benthic amphipod Pontoporeia affinis, and to a lesser extent M. relicta. Feeding of these two animals in the substrate and benthic boundary layer may function in a manner similar to activity of the planktonic crustaceans in fragmenting the diatom frustules and enhancing their dissolution. For this study, data were collected along a transect extending from Grand Haven, Michigan 12.5 km southwest into the lake. Sediment traps were suspended in the hypolimnion at depths of 37 and 60 m; samples were also collected with a towed net. Paucity of frustules in lake sediment demonstrated that these decompose prior to reaching the sediment. (Lynch-Wisconsin)
W79-08874

PHOSPHORUS CYCLING AND ALGAE IN GREEN BAY, LAKE MICHIGAN,
Wisconsin Univ., Green Bay. Coll. of Environmental Sciences.
J. C. Norman, and P. E. Sager.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 329-333. 1 fig, 2 tab, 13 ref.

Descriptors: *Green Bay(Lake Michigan), *Phosphorus, *Cycling nutrients, *Phytoplankton, *Turnovers, *Eutrophication, *Lake Michigan, Fox River(WI), Bays, Great Lakes, Lakes, Nutrients, Algae, Biomass, Chlorophyll, Metabolism, Mixing, Dilution, Phosphates, Trophic level, Orthophosphate, Limiting factors, Saturation, Luxury absorption.

Trophic gradients in Green Bay, Lake Michigan, from hypereutrophic at the southern end to oligotrophic at the northern end, were used to examine phosphorus cycling rates relative to soluble phosphate availability, algal biomass, and luxury phosphorus storage by algae. The steep gradients in phosphate and phytoplankton biomass (as chlorophyll-a) along a transect extending north 15 km into the bay from the mouth of the Fox River contrasted greatly with the uniform phosphorus cycling rates between algae and water. It is suggested that similarities in turnover rates of phosphorus per unit phytoplankton biomass are due to phosphate availability at levels exceeding limiting concentrations, leading to a saturation effect in phosphorus metabolism by the phytoplankton. Variations in observed phytoplankton biomass concentrations may be accounted for by the dynamic conditions of mixing and dilution in this estuary-like body of water, and the continuous outward transport of water masses from the phosphorus-rich Fox River. It has been shown previously that an important feature of phosphorus metabolism by algae is the assimilation and rapid release of a relatively small phosphate pool; phosphate is rapidly exchanged between soluble and particulate fractions in lake water with turnover times as low as several minutes. Lean established the importance of ultraplankton in rapid phosphorus turnover by seston, and that additional soluble and colloidal compartment may participate in the exchange process. Algal utilization of phosphorus is further complicated by luxury uptake. (Lynch-Wisconsin)
W79-08875

VERTICAL AND SEASONAL DISTRIBUTION OF CHLOROPHYLL A AND NUTRIENTS IN LAKE MICHIGAN,
Wisconsin Univ.-Milwaukee. Dept. of Zoology.
A. S. Brooks, and J. A. Mortonson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 334-335. 3 ref.

Descriptors: *Lake Michigan, *Chlorophyll, *Phytoplankton, *Nutrients, *Vertical distribution, *Hypolimnion, *Eutrophication, Great Lakes, Lakes, Distribution, Seasonal, Thermal stratification, Algae, Zooplankton, Grazing, Fish, Primary productivity, Depth.

A subthermocline chlorophyll-a maximum in southern Lake Michigan contained the bulk of algal biomass during summer with significant energy transfer and nutrient cycling in this zone. This influenced phytoplankton abundance and composition in surface water during autumn (upward mixing of previously formed chlorophyll increased the chlorophyll content in the mixed layer, giving the false impression of a surface autumn bloom). The study was conducted at a 100-m deep station 27 km northeast of Milwaukee, Wisconsin April 1975-September 1976. Chlorophyll-a was homogeneous in the water column (1 mg/cu m) during winter, but increased uniformly at all depths March-May, reaching maxima of 3.8 mg/cu m by 27 May 1975 and 2.1 mg/cu m by 26 May 1976. Reactive silicon dioxide decreased concurrently 0.7 to 0.2 mg/l; uniform distributions of nitrate (0.23 mg/l), nitrite (0.001 mg/l), dissolved reactive phosphorus (0.001 mg/l), and total phosphorus (0.006 mg/l) were found. With thermal stratification in June a subthermocline chlorophyll-a peak developed between 15 and 35 m, reaching maxima of five mg/cu m by 7 July 1975 and 10 mg/cu m by 14 July 1976. SiO2 decreased to 0.1 mg/l in the epilimnion, but increased to 1.0 mg/l at 100 m; nitrate changed little, nitrite showed a distinct maximum of 0.010 mg/l just below the chlorophyll peak, and total phosphorus a maximum of 0.020 mg/l at the depth of the chlorophyll peak. The major chlorophyll-a peak collapsed in mid-August, followed by lesser peaks at 10 and 30 m. At overturn, nutrients and chlorophyll-a were once again uniformly distributed. (Lynch-Wisconsin)
W79-08876

DISSOLUTION OF DIATOM FRUSTULES AND SILICON CYCLING IN LAKE MICHIGAN, U.S.A.,
Argonne National Lab., IL.
J. I. Parker, H. L. Conway, E. M. Yaguchi, and D. N. Edgington.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 336-340. 11 ref.

Descriptors: *Lake Michigan, *Silicon, *Cycling nutrients, *Diatoms, *Frustules, *Eutrophication, *Sediment-water interfaces, Great Lakes, Lakes, Zooplankton, Grazing, Sediments, Chrysophyta, Algae, Phytoplankton, Hypolimnion, Epilimnion, Distribution, Vertical distribution, Recycling, Degradation(Decomposition), Limiting factors, Nutrients.

Most of the annual silicon requirement for diatom production in Lake Michigan is provided by diatom frustule dissolution, enhanced by zooplankton grazing. Inputs of soluble reactive silicon (rSi) from land drainage compensates for loss of frustules to the sediment, providing about 2.5-3.0% (1.66 g Si/sq m/yr) of the estimated annual diatom requirement of 53 g Si/sq m/yr; some 1.33 g Si/sq m/yr are lost to sediments. About 76-98% of frustules are dissolved before they can be incorporated into bottom sediments, possibly providing rSi to the hypolimnion by diffusion. Data was collected on monthly cruises April-December 1975 at a station west of Grand Haven, Michigan; vertical distribution of total suspended sediment and diatom abundance and biomass was measured at five-m intervals to a depth of 40 m. Maximal epilimnetic rSi levels occurred in winter-early spring, declining rapidly during developments of the May-June diatom bloom. Particulate amorphous silicon or diatom frustules (aSi) increased during the bloom, coinciding with peaks in diatom abundance and biomass. Diatom abundance declined when rSi levels fell below about 6.8 micromoles, and minimal epilimnetic total silicon levels occurred in early August with zooplankton grazing and frustule settling. By early fall advective transport of hypolimnetic rSi to the epilimnion initiated the fall diatom bloom, which peaked in October-November. (Lynch-Wisconsin)
W79-08877

SPATIAL HETEROGENEITY AND NICHE DIFFERENTIATION IN ZOOPLANKTON OF LAKE HURON,
State Univ. of New York at Albany. Dept. of Biological Sciences.
D. C. McNaught.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 341-346. 1 fig, 3 tab, 16 ref. NSF OCE75-23710.

Descriptors: *Lake Huron, *Diaptomus minutus, *Holopedium gibberum, *Zooplankton, *Ecology, *Niches, *Spatial distribution, *Vertical migration, Great Lakes, Lakes, Crustaceans, Copepods, Cladocera, Food habits, Feeding rates, Phytoplankton, Grazing, Algae, Predation, Morphology, Habitats, Herbivores, Buoyancy, Behavior, Eutrophication, Size, Competition, Langmuir circulation.

The passively drifting cladoceran Holopedium gibberum is contrasted with the actively swimming calanoid copepod Diaptomus minutus in Lake Huron to clarify ecological differences and adaptations between the two zooplankters, which represent extremes among common herbivores. Spatial heterogeneity (habitat selection and temporal behavior) is more important than selective feeding in stabilizing such natural zooplankton populations. Both species preferred small phytoplankton cells (< 22 micrometers) rather than large cells. Holopedium is surrounded by a large gelatinous sheath composed of carbohydrates (9.6% pentose) and spends little time swimming. It readily adjusts to the density of its environment, whereas Diaptomus, with a density 3% greater than water, must constantly swim to stay at the surface, but can search for food both horizontally and vertically while Holopedium passively moves at diffusion velocities (20 sq cm/sec). During daylight populations of both animals migrate downward. Holopedium populations daily harvest only 0.6% of the phytoplankton standing crop in low production areas of Lake Huron, but leave essentially no untouched food (no prey refugium). Diaptomus removes only 0.09% of the phytoplankton in sparse phytoplankton areas, being essentially adapted for feeding in high-density eutrophic areas, where it can afford to leave a large refugium. The large Holopedium (> two mm) avoids predation through bad taste, while Diaptomus does so through small size (< one mm). (Lynch-Wisconsin)
W79-08878

THE RESPONSE OF CLADOPHORA GLOMERATA TO CHANGES IN SOLUBLE ORTHOPHOSPHATE CONCENTRATIONS IN LAKE ERIE,
State Univ. of New York Coll. at Fredonia. Dept. of Geology.
K. E. Mantai.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 347-351. 3 fig, 9 ref. NSF OCE75-23710.

Descriptors: *Cladophora glomerata, *Lake Erie, *Bioassay, *Orthophosphate, *Nutrients, *Limiting factors, *Sampling, algae, Sessile algae, Chlorophyta, Filamentous algae, Great Lakes, Lakes, Growth rates, Plant growth, Seasonal, Plant physiology, Nitrates, Iron, Luxury absorption, Nitrogen, Phosphorus, Sampling, Phosphatases.

Laboratory bioassays showed that the growth pattern of the sessile, filamentous chlorophyte Cladophora glomerata in Lake Erie is complex and cannot be explained in terms of simple nutrient limitation. Neither phosphorus nor nitrate appeared limiting in this study except during short periods (such as nitrate during mid-July 1975). Some other unmeasured nutrient (possibly iron) may be rate-limiting, and Cladophora requires both thiamine and vitamin B-12 for growth in culture. High alkaline phosphatase activity does not necessarily indicate long-term phosphorus limitation, but can be the result of a change in ambient phosphate concentration. Following exposure to high phosphate pulses cells change from a luxury consumption pattern to one in which phosphate apparently is limiting based on alkaline phosphatase activity, despite the adequate phosphate in the water. After one to several days cells readapt to the lower phosphate concentration and alkaline phosphatase activity drops to a low value. When studying natural Cladophora glomerata populations in areas characterized by rapid fluctuations in environmental parameters such as in lake wave zones and rivers, frequent sampling is needed. Samples were collected in spring-summer 1975-76 at Point Gratiot, near Dunkirk, New York on Lake Erie's eastern basin. (Lynch-Wisconsin)
W79-08879

HIGH MOLECULAR WEIGHT POLYSACCHARIDES ISOLATED FROM LAKE WATER,
Canada Centre for Inland Waters, Burlington (Ontario).
B. K. Burnison.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 353-355. 9 ref.

Descriptors: *Polysaccharides, *Bay of Quinte(Ontario-Canada), *Lake St George(Ontario-Canada), *Organic matter, *Chemical analysis, Lakes, Bays, Eutrophication, Ontario(Canada), Canada, Algae, Phytoplankton, Microcystis aeruginosa, Cyanophyta, Tracers, Phosphates, Heavy metals, High molecular weight, Analytical techniques, Methodology, Lake Ontario, Great Lakes.

Chemical analysis of high molecular weight organic material (> 300,000) showed polysaccharides are a major component of water samples collected in the eutrophic lake north of Toronto free of significant industrial influence. Such high molecular weight compounds may act as ion exchangers to transport nutrients to algal cells or they may bind heavy metal ions, thus protecting the algae from toxic concentrations. The high molecular weight material can be labelled with phosphorus-32 phosphate, but it is not known whether the P-labelled compound is identical with the polysaccharide component. The Bay of Quinte sample, collected during a bloom of the cyanophyte Microcystis aeruginosa, consisted of 80% neutral sugars by dry weight, especially galactose (40%), glucose (12%), xylose (11%), rhamnose (8%), and fucose (7%). Uronic acid was about 20% of the total. Polysaccharides varied 2-40% of total dissolved organic carbon, and was dependent on phytoplankton biomass. The polysaccharides may be solubilized sheath material from Microcystis. The Lake St. George sample differed greatly; only 30% of total dry weight of each fraction analyzed could be accounted for by neutral sugars. Maximum contribution of organic nitrogen compounds was estimated at 10%, and lipids less than 1%; about 30% was undetermined. About 21% showed some similarity to lipopolysaccharides. (Lynch-Wisconsin)
W79-08880

PHYTOPLANKTON-VOLUME-BASED PRODUCTIVITY IN THE NORTH AMERICAN GREAT LAKES AND THE ST. LAWRENCE RIVER,
Southern Illinois Univ. at Carbondale. Dept. of Botany.
N. R. Wehr, and J. Verdun.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 356-361. 3 fig, 2 tab, 7 ref.

Descriptors: *Phytoplankton, *Great Lakes, *Photosynthesis, *Volume, *Species composition, *St Lawrence River, *Diversity indices, Primary productivity, Algae, Species diversity, Lakes, Rivers, Lake Michigan, Lake Superior, Lake Huron, Lake Ontario, Lake Erie, Diatoms, Chrysophyta, Cyanophyta, Chlorophyta, Biovolume, Dominant organisms, Asterionella formosa, Tabellaria fenestrata, Coscinodiscus rothii, Fragilaria crotonensis.

Photosynthetic rates/l (P), phytoplankton biovolumes (B), P/B ratios, and species composition, dominance, and diversity are compared for the Great Lakes and St. Lawrence River based on data collected during the summers of 1969, 1971, and 1973. Lakes Superior and Michigan are upper-end lakes, and Lake Huron is a mixture of waters from the two. These three lakes exhibited relatively low values of photosynthetic rate and phytoplankton biovolume. Lake Superior was lowest (P=about 0.1 micromol CO2/l/hr, B=about 0.1 microliter algae/l), followed by Lake Huron (P=0.3, B=0.4), and Lake Michigan (P=0.8, B=0.5). A dramatic peak was observed in Lake Erie's western basin (P=6, B=5), and the rest of Lake Erie and Lake Ontario were distinctly higher than the three upper lakes (P=1.4, B=1.0), though much lower than the western basin. The St. Lawrence River exhibited high photosynthetic rates (P=9) but relatively low phytoplankton biovolume (B=0.4), resulting in a P/B ratio higher than in any of the lakes. The three upper-end lakes were dominated by the diatoms Asterionella formosa, Tabellaria fenestrata, and Fragilaria crotonensis), while Lakes Erie and Ontario were dominated by different diatoms (Coscinodiscus rothii, Melosira sp., and Fragilaria capucina) and contained dominant biovolumes of chlorophytes (Pediastrum and Cosmarium) and cyanophytes. P/B ratios showed a positive correlation with Simpson's Diversity Index. (Lynch-Wisconsin)
W79-08881

SURVIVAL VERSUS COMPETITION: EVOLUTIONARY COMPROMISES AND DIVERSITY IN THE ZOOPLANKTON,
Dartmouth Coll., Hanover, NH. Dept. of Biological Sciences.
W. C. Kerfoot, and R. A. Pastorok.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 362-374. 7 fig, 1 tab, 37 ref. NSF GB-37631, GMS 73-06845A01, DEB 76-20238.

Descriptors: *Zooplankton, *Survival, *Competition, *Predation, *Population dynamics, *Adaptation, *Genetics, *Evolution, *Reproduction, Species diversity, Tuck Lake(WA), Lake Washington(WA), Biological communities, Size, Fish, Lakes, Washington, Limiting factors, Food habits, Fecundity, Mortality, Filter feeders, Copepods, Daphnia pulex v. minnihaha, Daphnia schoedleri, Bosmina longirostris, Diaphanosoma leuchtenbergianum, Chydorus sphaericus, Mathematical models, Model studies.

Field experiments in Tuck Lake (Washington) and laboratory experiments with samples from Lake Washington (Washington) to study survival and competition among several common zooplankton species showed that compensatory defenses developed by prey of larger zooplankters result in inferior ability to compete with species of similar size. The energy costs of developing such defenses as production of spines, gelatinous sheaths, or larger eggs and neonates, or reduction of pigment to increase transparency (with resultant higher susceptibility to blue-light death) have significant effects on competitive ability and consequent effects on diversity. Predation by fish further intensifies such effects. Zooplankters investigated included Daphnia pulex v. minnihaha and D. schoedleri; Bosmina short- and long-featured 'morphs'; and Daphnia pulex, Diaphanosoma leuchtenbergianum, Bosmina longirostris, and Chydorus sphaericus. Experiments showed: (1) Lake Washington Bosmina 'morphs' with longer features and protective characteristics (such as thicker exoskeletons) survive in nature more because of resistance to predation than because of ability to compete for shared resources. (2) Daphnia and other Tuck Lake zooplankton persist in backwater not because they are better competitors but because of larger size and thicker carapace. It is concluded that selective predation may serve to stabilize species associations in homogeneous open-water environments. (Lynch-Wisconsin)
W79-08882

DOCUMENTING A SEASONAL CHANGE FROM PHOSPHORUS TO NITROGEN LIMI-

TATION IN A SMALL TEMPERATE LAKE, AND ITS IMPACT ON THE POPULATION DYNAMICS OF ASTERIONELLA,
Washington Univ., Seattle. Dept. of Zoology.
J. T. Lehman, and C. D. Sandgren.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 375-380. 4 fig, 6 ref.

Descriptors: *Asterionella formosa, *Phosphorus, *Nitrogen, *Limiting factors, *Egg Lake(WA), *Population dynamics, *Eutrophication, *Seasonal, Phytoplankton, Algae, Seasonal, Chlorophyll, Washington, Lakes, Temperate, Nutrients, Stratification, Nuphar, Potamogeton, Macrophytes, Dominant organisms, Water chemistry, Succession, Diatoms, Chrysophyta.

Initial growth of the diatom Asterionella formosa in April 1976 prior to its spring bloom in Egg Lake in San Juan Island, Washington, was limited by phosphorus, while decline of the alga following its peak on 7 May was due to low nitrogen and reduced mixing in the water column from intensified stratification. Nitrogen limitation for Asterionella is noteworthy since silicon and phosphorus are currently emphasized as major factors governing growth of the diatom. Ability of this species to respond so well to added phosphorus may in fact have been responsible for its becoming the dominant planktonic species when nitrogen supplies became exhausted. Toward the end of April there began a net influx of phosphorus into the water column (specifically the surface layer) which coincided with development of submerged (Potamogeton) and emergent (Nuphar) macrophytes. Added initially to a phosphorus-limited plankton, most of the phosphorus was absorbed into the particulate fraction, and the increase in particulate phosphorus was paralleled by an increase in Asterionella cell numbers. Subsequent nitrogen limitation resulted in sinking diatoms removing sufficient particulate phosphorus from the water column to significantly reduce lake total phosphorus, despite continued lateral phosphorus inputs. In late May-June diatoms were replaced by slow-sinking, primarily flagellated algal species. (Lynch-Wisconsin)
W79-08883

DIEL VERTICAL MIGRATION AND DYNAMICS OF ZOOPLANKTON BIOMASS IN THE EPILIMNION OF CASTLE LAKE, CALIFORNIA,
California Univ., Davis. Div. of Environmental Studies.
G. W. Redfield, and C. R. Goldman.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 381-387. 4 fig, 1 tab, 14 ref. NSF BM 74-02246 A01 and DEB 76-19524.

Descriptors: *Castle Lake(CA), *Diel migration, *Vertical migration, *Zooplankton, *Epilimnion, *Biomass, Lakes, California, Biorhythms, Feeding rates, Grazing, Seasonal, Daphnia rosea, Holopedium gibberum, Diaptomus novamexicanus, Cladocera, Copepods, Species composition, Juvenile growth stage, Succession, Growth stages, Diurnal, Nocturnal, Migration.

Study of diurnal, nocturnal, and migratory zooplankton biomass in the epilimnion of dimictic, subalpine Castle Lake in the Klamath Mountains of northern California in 1975-76 showed evening ascent had a distinct effect on epilimnetic biomass, with nocturnal levels 290-346% of midday levels. Biomass ascending into the epilimnion generally followed total biomass, thought it was greatly affected by behavior of species and by age classes. Migratory biomass (the difference between diurnal and nocturnal values) was influenced by changes in vertical distribution, community composition, nutrition, and weather. Samples of the dominant species, Daphnia rosea, Holopedium gibberum, and Diaptomus novamexicanus were separated into adults and juveniles. A Diaptomus-Holopedium-Daphnia succession was observed June-September, representing a shift toward greater nocturnal/diurnal ratios. Diurnal biomass remained relatively stable seasonally, while nocturnal biomass steadily increased. Data were separated into McAlliser's continuous and nocturnal grazing schemes. In Castle Lake juvenile-dominated diurnal zooplankton constituted continuous grazers, while adult-dominated migratory biomass represented nocturnal grazers. High night grazing rates resulting from diel vertical migration may have improved efficiency and utilization of primary production by reducing losses through night respiration and allowing relatively unimpeded daylight growth. (Lynch-Wisconsin)
W79-08884

NITRATE UPTAKE BY PHYTOPLANKTON: MEASUREMENTS UTILIZING THE RADIOTRACER 13N,
California Univ., Davis. Div. of Environmental Studies.
R. M. Gersberg, R. P. Axler, K. Krohn, N. Peek, and C. R. Goldman.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 388-392. 2 fig, 1 tab, 18 ref. NSF BM 74-02246 A01, DEB 76-19524.

Descriptors: *Nitrates, *Phytoplankton, *Absorption, *Methodology, *Measurement, *Tracers, *Analytical techniques, Mrak Pond(CA), Castle Lake(CA), California, Lakes, Ponds, Algae, Nitrogen, Radioactivity, Radiochemical analysis, Cycling nutrients, Equations, Testing procedures.

A new technique is described for measuring phytoplankton nitrate uptake rates using the radiochemical nitrate-13, which has measured rates as low as 4.5 ng N/hr in oligotrophic Castle Lake, California. Initial experiments were conducted at eutrophic Mrak Pond at the University of California-Davis. Nitrogen-13 allows measurements over very short time intervals and low reaction rates without significantly raising substrate concentration. Subsurface water samples were collected from Mrak Pond and prefiltered to remove zooplankton. Nitrate-13 (at about 20 m/Ci) was pumped into 400 ml of the water, and 10-ml aliquots were filtered, rinsed, and analyzed for soluble nitrate. Filter radioactivity was counted with a NaI(Tl) crystal detector with an amplifier and single channel analyzer (SCA). Nitrogen-13 decays by emission of positrons, which yield two 0.511 MeV gamma rays. With the SCA window set to detect only gamma rays of this energy, the output logic pulse was used to drive a scaler. Calibration standards were prepared, and solution activity determined by counting 10 ml of filtrate in an ion chamber and by depositing 0.5 ml of filtrate onto Whatman-l filters and counting as with the particulate filters. NaI(Tl) crystal-detected counts were corrected for post-filtration decay, and for the aliquot factor; data provided a graph of N-13 activity accumulation in the total particulate fraction over time. A differential equation is provided for calculating uptake rate. (Lynch-Wisconsin)
W79-08885

AN EVALUATION OF RECENT SEDIMENT FOCUSING INCASTLE LAKE (CALIFORNIA) USING A VOLCANIC ASH LAYER AS A STRATIGRAPHIC MARKER,
Oklahoma Univ., Norman. Dept. of Zoology.
B. L. Kimmel.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 393-400. 3 fig, 1 tab, 25 ref. NSF DEB 76-19524.

Descriptors: *Sediment focusing, *Castle Lake(CA), *Volcanic ash, *Depth, *Slopes, *Lake morphology, *Sedimentation, Sediments, California, Lakes, Paleoecology, Paleolimnology, Winds, Turbulence, Circulation, Stratification, Mixing, Cores, Stratigraphy.

Sediment focusing, or net movement of sedimented materials from shallower to deeper water, occurs in sheltered Castle Lake in northern California's Klamath Mountains, but is a function not only of water depth (geometric focusing) but also of proximity to steep bottom slopes or irregularities of shape. Basin morphology is thus the primary determinant of sediment focusing extent, since wind-driven mixing in Castle Lake is minimal relative to many other holomictic lakes. A light-colored layer of volcanic ash below the sediment surface provides a convenient stratigraphic marker for determining the thickness of recent sediments. Sediment thickness generally increases with water depth at stations ranging 14-36 m, increasing from 46 cm at the shallowest station to 55-62 cm at four of the five 35-36 m stations. Several anomalies were observed, however. At one of the 36-m stations 66 cm of sediment accumulated even though it was located in the same vicinity as the other deep-water stations, and at station J, located near a submerged moraine, 60 cm of sediment accumulated in only 17 m of water. Within-station variance in sediment thickness was low (less than 5%) at four stations where two or three cores were taken. The existence of sediment focusing shows that choice of coring stations is critical if representative samples are to be obtained. Low-frequency echosounders may provide a good method for determining sediment accumulation patterns and for selecting sampling sites. (Lynch-Wisconsin)
W79-08886

SURVIVAL OF APHIOTIC PHYTOPLANKTON IN LAKE TAHOE THROUGHOUT PROLONGED STRATIFICATION,
California Univ., Davis. Inst. of Ecology.
W. Vincent.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 401-406. 1 fig, 3 tab, 11 ref. NSF DEB 76-11095.

Descriptors: *Stratification, *Lake Tahoe(CA NV), *Phytoplankton, *Aphotic zone, *Survival, *Deep-water habitats, Algae, California, Nevada, Chlorophyll, Lakes, Depth, Mixing, Photosynthesis, Light intensity, RuDPCase, Ribulose 1.5-diphosphate carboxylase, Euphotic zone, Eutrophication, Dormancy, Darkness, Sedimentation, Enzymes, Settling velocity, Oligotrophy, Vertical distribution.

Phytoplankton deep in the aphotic zone of Lake Tahoe (California, Nevada) during periods of thermal stratification which may exceed 12 mo, are not in a state of true physiological dormancy, but are photosynthetically primed for reentry into euphotic waters upon lake mixing. In the 350-450 m stratum, chlorophyll content did not change significantly December 1975-May 1977, indicating little exchange between the deep aphotic zone and overlying waters, even during surface mixing in early 1976. Algae collected from the deep zone began photosynthesizing immediately upon reexposure to euphotic light levels, but photosynthetic rates did not increase with up to 116 hrs of further preincubation in the light. Ribulose 1.5-diphosphate carboxylase (RuDPCase), the enzyme catalyzing the rate-determining step of the dark reactions (reductive pentose phosphate cycle) of photosynthesis, did not differ statistically in concentration per unit microbial biomass between communities of the deep aphotic zone and the euphotic zone. Settling velocities for six aphotic algae isolated into unialgal culture and measured over a wide range of nutritional conditions were too slow to account for a recent euphotic origin of these cells by passive sedimentation. Species included Choricystis sp., a Chlorosphaeralean, Chlorella saccharophila var. saccharophila, Stichococcus chodati, Monoraphidium contortum, and Fragilaria crotonensis. (Lynch-Wisconsin)
W79-08887

PREDICTIONS OF PRODUCTIVITY CHANGES IN LAKE TAHOE AT INCREASING PHYTOPLANKTON BIOMASS,
Konstanz Univ. (Germany, F. R.). Limnology Inst.
M. M. Tilzer.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August

1977. Vol. 20, September 1978, Part 1, p 407-413. 3 fig, 2 tab, 22 ref.

Descriptors: *Phytoplankton, *Lake Tahoe(CA NV), *Primary productivity, *Eutrophication, *Biomass, *Water pollution effects, *Forecasting, Algae, Lakes, California, Nevada, Photosynthesis, Chlorophyll, Trophic level, Nutrients, Oligotrophy, Secchi disks, Transparency, Limiting factors, Nitrates, Regression analysis, Shading.

Regression analysis applied to primary productivity parameters monitored in 1974 in ultraoligotrophic Lake Tahoe (California, Nevada) facilitated predictions of changes in phytoplankton photosynthesis which would accompany increasing phytoplankton biomass (chlorophyll-a) with eutrophication of the lake. Photosynthetic profiles would become compressed vertically but photosynthetic rates per unit volume would rise. An increment of chlorophyll-a from 0.1 to 10 mg/cu m would lead to only a 14-fold increase in average photosynthetic rates in the trophogenic zone, and due to self-shading integral photosynthesis would rise by no more than 80%. With increased phytoplankton biomass, light extinction would increase rapidly, but nonplant light extinction would also rise with enrichment of detritus, bacteria, zooplankton, and dissolved organic matter. A shift toward green in lake color would decrease light extinction, as would an increase in average phytoplankter size. At present maximum winter concentrations of nitrate-nitrogen, the main limiting nutrient, are extremely low (13 mg/cu m); since increases which may be significant for phytoplankton growth are hardly detectable; primary productivity has been used as a measure of changes over the past 18 years, during which productivity has increased about 60%. Data from other lakes are included for comparison. (Lynch-Wisconsin)
W79-08888

AN AUTORADIOGRAPHIC INVESTIGATION OF THE SEASONAL PHOTOSYNTHETIC ACTIVITY OF THREE DIATOM SPECIES IN LAKE TAHOE, CALIFORNIA-NEVADA,
Oak Ridge National Laboratory, TN.
B. J. Dozier, and J. J. Beauchamp.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 414-418.

Descriptors: *Lake Tahoe(CA NV), *Autoradiography, *Limiting factors, *Diatoms, *Phytoplankton, *Photosynthesis, California, Nevada, Lakes, Algae, Chrysophyta, Stephanodiscus astraea, Fragilaria crotonensis, Cyclotella stelligera, Regression analysis, Seasonal, Oligotrophy, Nitrates, Phosphorus, Water temperature, Light intensity, Nutrients, Films, Succession, Zooplankton, Grazing, Methodology.

Seasonal photosynthetic activity of three dominant diatom species in ultraoligotrophic Lake Tahoe (CA, NV) was measured by autoradiography, in 1975. The influence of water temperature, light available for photosynthesis, nitrate nitrogen, and total phosphorus on species-specific variation in photosynthetic activity was analyzed by stepwise multiple regression. Declining phytoplankton populations in Lake Tahoe were precipitated by an unfavorable change in the physico-chemical environment rather than by zooplankton grazing, since in all three cases population reduction followed declining photosynthetic activity. Data also support the overriding influence of nitrate nitrogen over phosphorus as a limiting nutrient in Lake Tahoe. Of the four parameters, water temperatures was the most ciritcal affecting photosynthetic rate at 50 m of Stephanodiscus astraea, while nitrate nitrogen was the most important for Cyclotella stelligera, and to a lesser extent Fragilaria crotonensis. For all three species temperature correlated inversely with photosynthetic activity. Algal samples were injected with carbon-14 sodium bicarbonate solution with an activity of 9.2 microCi/ml. Incubated and filtered samples were packaged with Kodak AR10 Autoradiographic Stripping Plates and exposed for 3-6 weeks; five proved optimal. Results were evaluated according to silver grain density. (Lynch-Wisconsin)
W79-08889

ANNUAL VARIATION OF PHOTOSYNTHETIC PARAMETERS IN LAKE TAHOE,
CH2M/Hill, Inc., San Francisco, CA.
N. J. Williams.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 419-425. 4 fig, 1 tab, 12 ref. NSF-RANN GI-22, AEN 74-22675.

Descriptors: *Lake Tahoe(CA NV), *Photosynthesis, *Primary productivity, *Vollenweider models, *Steele equation, *Light intensity, *Equations, Forecasting, Annual, Lakes, California, Nevada, Succession, Species composition, Limiting factors, Parameters, Chlorophyll, Model studies, Mathematical models, Seasonal, Water management(Applied), Water temperature, Nitrates.

The Steele (1962) and Vollenweider (1965) equations relating primary production to light intensity were fitted to the annual cycle of primary production in ultraoligotrophic Lake Tahoe (California, Nevada), based on 1974 data. Both equations account for the occurrence of photoinhibition at high light intensities. The Vollenweider equation was adjusted for the Steel parameters maximum production/chlorophyll and optimum light intensity, and another parameter was added, the initial slope of the light production curve. The two equations explained about 90% of total annual variation in specific production. Equation parameters showed systematic and significant annual variation which correlated with environmental conditions. The best-fit optimum light intensities showed dramatic seasonality. Optimum light intensity was controlled by average light intensity in the mixed layer, the initial slope by nitrate concentration, and maximum specific production by nitrate and temperature. By relating the parameters to the environmental conditions it was possible with the Vollenweider equation to account for 44% of the observed variation in specific production, and 67% with the Steele equation. Steele equation terms include production/chlorophyll, light intensity, maximum production/chlorophyll, and light intensity at which production/chlorophyll = maximum production/chlorophyll. The Vollenweider equation includes production/chl, light intensity, a production parameter, a light parameter, and light inhibition parameters. (Lynch-Wisconsin)
W79-08890

THE DEEP CHLOROPHYLL LAYER OF LAKE TAHOE,
California Univ., Davis. Div. of Environmental Studies.
P. J. Richerson, M. Lopez, and T. Coon.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 426-433. 2 fig, 20 ref. NSF BMS 75-14273.

Descriptors: *Lake Tahoe(CA NV), *Chlorophyll, *Deep water, *Phytoplankton, *Diatoms, *Cyclotella ocellata, California, Nevada, Lakes, Oligotrophy, Shading, Algae, Cyclotella stelligera, Biomass, Depth, Vertical distribution, Chrysophyta, Zooplankton, Photosynthesis, Primary productivity, Grazing, Nutrients, Respiration, Settling velocity, Water temperature.

Six hypotheses offered by several authors to explain the occurrence in lakes of deep chlorophyll maxima in the vicinity of the compensation depth were evaluated with 1976-77 data for ultraoligotrophic Lake Tahoe (California-Nevada). All six fit Lake Tahoe to some degrees, but none too strongly. Shade adaptation was surprisingly unimportant. The six hypotheses are: (1) The layer may be a by-product of shade adaptation; chlorophyll per unit cell biomass may increase with depth, but not biomass itself. (2) Zooplankton biomass may be higher above the maximum and grazers may prune the upper part of the profile. (3) Better nutrient conditions at depth may permit biomass to accumulate despite low photosynthetic rates. (4) Lower respiration rates could permit differential biomass accumulation at depths; such lower rates could be due to low temperatures or secondarily to better nutrient conditions which favor cells with smaller surface-to-volume ratios. (5) The layer could result from differential sinking rates of cells in nutrient-poor surface waters compared with nutrient-rich deeper waters. (6) Eucaryotic cells may be able to compete with bacteria for organic substrates at low temperatures, and it has been shown that heterotrophic uptake is a very strong function of temperature in Lake Tahoe. The Lake Tahoe epilimnion is consistently dominated by the very small diatom Cyclotella stilligera, while at the deep maximum (peak at 105 m) the much larger C. ocellata was dominant. (Lynch-Wisconsin)
W79-08891

ANOMALOUS PRIMARY PRODUCTION CONDITIONS IN SOME COLORADO ALPINE LAKES, U.S.A.,
Colorado Univ., Boulder. Dept. of Biology.
R. W. Pennak.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 434-437. 3 tab, 9 ref.

Descriptors: *King Lake(CO), *Yankee Doodle Lake(CO), *Black Lake(CO), *Primary productivity, *Testing procedures, *Dissolved oxygen, Colorado, Lakes, Phytoplankton, Algae, Diatoms, Zooplankton, Alpine, Water temperature, Methodology, Depth, Seston, Hardness(Water), Respiration, Oligotrophy, Polyarthra, Kellicottia longispina, Ceratium hirundinella, Daphnia ambigua, Peridinium, Synedra, Asterionella, Oocystis, Dinobryon.

Anomalous primary production data from light-dark bottle experiments in King, Yankee Doodle, and Black Lakes in the Rocky Mountain Front Range near Boulder, Colorado, are associated with low water temperatures, soft water, low phytoplankton and zooplankton densities, low seston, and microbiological phenomena; however, no conclusive explanations have been found. Of 25 data sets, 23 showed greater oxygen production in dark bottles than in corresponding light bottles. The greatest 24-hr increase was 1.41 ppm at a depth of 8 m in King Lake. Thirteen of the light bottles showed decreases in dissolved oxygen over starting values, with no depth correlation, and dark bottles showed greater average oxygen production below three m than above three m. It is recommended that light-dark bottle determinations in cold oligotrophic lakes be done with great care, and that even atypical results be reported. Such results have generally been dismissed in the past as experimental errors, apparently not the case. Though phytoplankton data for King and Yankee Doodle Lakes suggest considerable productivity potential, all species are small and seston quite low, as in other alpine lakes of the region. Zooplankton in the two lakes is extremely sparse, dominated by Polyarthra and Kellicottia longispina. Black Lake is dominated by Ceratium hirundinella, Daphnia ambigua, Peridinium, and Volvox. (Lynch-Wisconsin)
W79-08892

GROUND-WATER COMPONENT OF LAKE WATER AND NUTRIENT BUDGET,
Geological Survey, Denver, CO.
T. C. Winter.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 438-444. 3 fig, 6 ref.

Descriptors: *Groundwater, *Nutrient budgets, *Hydrologic budget, *Lakes, *Methodology, *Analytical techniques, Measurement, Aquifers, Runoff, Water table, Wells, Theoretical analysis, Equations, Surface runoff, Precipitation(Atmospheric), Evaporation, Streamflow, Seepage, Watersheds(Basins), Lake morphology.

The interrelationship of lakes and groundwater are analyzed with particular reference to errors implicit in considering groundwater either as unimportant in lake water and nutrient budgets, or as the residual of the budget equations. Serious errors and misinterpretations concerning these budgets arise because: (1) overland runoff, (nonchannelized surface flow) into the lake is rarely considered, and (2) errors in the measured parameters of inflow (usually precipitation and streamflow) and outflow (usually evaporation and streamflow) rarely are considered separately. Both factors thus become part of the residual along with groundwater. Recent theoretical studies show that the presence or absence of a continuous local groundwater flow system boundary beneath a lake controls whether or not there is outseepage from the lake. Continuity of the flow system boundary is controlled by the configuration of the water table in the lake drainage basin and by the permeability contrasts within the groundwater system. These studies have helped develop field analysis techniques for lake-groundwater interrelationships leading to realistic estimates of groundwater in lake water and nutrient budgets. Groundwater sampled from a well near the lake may not be related to the lake if the well is completed in a regional flow system passing at depth beneath the lake. (Lynch-Wisconsin)
W79-08893

ALGAL REMAINS IN MINNESOTA LAKE TYPES: A COMPARISON OF MODERN AND LATE-GLACIAL DISTRIBUTIONS,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
T. L. Crisman.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 445-451. 4 fig, 1 tab, 14 ref.

Descriptors: *Minnesota, *Lakes, *Paleolimnology, *Algae, *Sediments, *Trophic level, *Analytical techniques, Bioindicators, Pediastrum, Distribution, Depth, Water chemistry, Hydrogen ion concentration, Conductivity, Primary productivity, Eutrophication, Oligotrophy, Palynology, Paleontology, Hardness(Water), Gloeotrichia, Botryococcus, Peridinium, Staurastrum, Glaciology, Spruce trees, Pine trees, Factor analysis.

Data on distribution of 11 taxa of nondiatom algae in surficial sediments from 96 Minnesota Lakes in terms of water depth, lake chemistry, and productivity were used in paleolimnological reconstrations based on fossil algal assemblages from late- and post-glacial lake cores as six Minnesota sites. Principal component analysis was employed to divide the taxa into associated groups. Three major factors were identified, with 82% of variance explained by the first two factors. Gloeotrichia, Pediastrum boryanum, P. duplex, P. simplex, and P. kawraiskyi display maximal loading on Factor 1. Factor 2 is defined by strong positive loadings for Peridinium, Botryococcus, Pediastrum araneosum, and P. integrum, which respond positively to low pH and alkalinity, and secondarily to low productivity. Staurastrum is the sole taxon represented by Factor 3; Pediastrum tetras does not load strongly on any factor. Distribution of the 11 taxa is controlled more by water chemistry and productivity than by water depth. Peridinium and Botryococcus dominates fossil assemblages in soft-water oligotrophic lakes, but are replaced by Pediastrum in hard-water eutrophic lakes. All six sites are characterized by a Pediastrum peak during the late-glacial spruce zone, then a decline following early postglacial replacement of spruce by pine. Domination of the peak by P. boryanum and P. duplex indicates increased productivity and conductivity. (Lynch-Wisconsin)
W79-08894

MINERAL RELEASE FROM THE LITTER OF BIDENS CERNUA L., A MUDFLAT ANNUAL AT EAGLE LAKE, IOWA,
Iowa State Univ., Ames. Dept. of Botany and Plant Pathology.
C. B. Davis, and A. G. van der Valk.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 452-457. 2 fig, 1 tab, 17 ref.

Descriptors: *Eagle Lake(IA), *Bidens cernua, *Degradation(Decomposition), *Litter, *Minerals, *Mud flats, Lakes, Prairie, Iowa, Wetlands, Marsh plants, Macrophytes, Emergent plants, Drawdown, Aluminum, Iron, Nutrients, Phosphorus, Dry marsh phase, Calcium, Lake stages.

Stems of the emergent marsh macrophyte Bidens cernua killed by a severe frost at Eagle Lake, Iowa (a typical prairie glacial marsh lake), decomposed very slowly, releasing nitrogen, phosphorus, and calcium gradually over several years. Aluminum and iron were actually accumulated in the litter and only magnesium was released faster than dry weight was lost. Stems were collected on 14 October 1974 (three days after the frost) during drawdown of the lake initiated in spring 1974 to allow emergent species to reestablish. Stems were ovendried at 80C, cut into 20-cm segments, and placed in nylon mesh bags (50 g/bag). On 20 November 1974 39 bags were randomly distributed on the marsh floor. Lake water level returned to normal in 1975, and from March-July of 1975 and 1976 the study area was covered by about 15 cm water. Standing water disappeared during summer, but litter remained moist and the litter zone was probably aerobic during most of the study. Sample bags were collected at six-week intervals during the 1975 and 1976 growing seasons and analyzed. Soft pitch and epidermal tissues decomposed first, with a 23% wt loss fall 1974-spring 1975. Fibrous structural and vascular tissues broke down gradually; 50% wt loss did not occur until 578 days, and 73% until 724 days. On 9 October 1976 378% of initial aluminum content remained (corrected for wt loss), 349% of iron, 90% of nitrogen, 80% of calcium, 53% of phosphorus, and 17% of magnesium. Prairie glacial marsh 5-20 yr cycles are discussed. (Lynch-Wisconsin)
W79-08895

PHOSPHORUS RELEASE FROM LAKE SEDIMENTS AS AFFECTED BY CHIRONOMIDS,
Wisconsin, Univ.-Madison. Lab. of Limnology.
G. W. Gallepp, J. F. Kitchell, and S. M. Bartell.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 458-465. 2 fig, 2 tab, 19 ref. NSF AG-199, BMS 76-00761.

Descriptors: *Chironomidae, *Chironomus riparius, *Lake Mendota(WI), *Phosphorus, *Cycling nutrients, *Mud-water interfaces, *Sediments, Lakes, Wisconsin, Madison(WI), Oxidation-reduction potential, Benthic fauna, Mortality, Mud, Aerobic conditions, Darkness, Nutrients, Epilimnion, Eutrophication, Soluble reactive phosphorus, Insects, Larvae.

Larvae of the chironomide Chironomus riparius released six mg total phosphorus/sq m/day in mud collected from University Bay of Lake Mendota, Madison, Wisconsin; maintenance of such a rate during summer would provide a steady and significant amount of phosphorus to the epilimnetic community. Two experiments were conducted to determine the effect of C. riparius on phosphorus release from lake sediment. Chironomids were added to filtered lake water and mud in darkness and under aerobic conditions. After six days median total phosphorus level was 28 microg/l in tubes with no chironomids, 92 microg/l with 10 individuals, and 114 microg/l with 25 individuals. Testing for mortality during the second experiment showed 40% during the first week, which may explain the gradual decrease in phosphorus observed in the first experiment. Phosphorus movement between sediment and water is known to be affected by benthic organisms, including bacteria, algae, and tubificids, but burrowing larval chironomids have been neglected. These larvae are uniquitous and dominant in benthos of eutrophic lakes where phosphorus loading is of great concern. Chironomids increase sediment oxygen penetration, and increase the redox potential of surface mud layers. Sediment was collected from the upper 10-20 cm of the bay's substrate in 4-6 m water, and C. riparius from the Madison sewage outfall. Tests were conducted in polycarbonate tubes 48 cm long and 6.9 cm inside diameter. (Lynch-Wisconsin)
W79-08896

SEASONAL IMPACT OF PLANKTIVORY ON PHOSPHORUS RELEASE BY LAKE WINGRA ZOOPLANKTON,
Wisconsin Univ.-Madison. Lab. of Limnology.
S. M. Bartell, and J. F. Kitchell.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 466-474. 5 fig, 2 tab, 20 ref. NSF AG-199, BMS 76-00761.

Descriptors: *Lake Wingra(WI), *Zooplankton, *Sunfishes, *Predation, *Phosphorus, *Cycling nutrients, Lakes, Wisconsin, Madison(WI), Eutrophication, Fish, Fish food organisms, Size, Lepomis macrochirus, Daphnia galeata, Model studies, Bosmina longirostris, Cyclops bicuspidatus, Diaptomus siciloides, Feeding rates, Food habits, Cladocera, Copepods, Statistical models, Seasonal, Limnetic zone.

Predation by bluegill sunfish (Lepomis macrochirus) reduces phosphorus release from limnetic zooplankton by one order of magnitude in eutrophic Lake Wingra (Madison, Wisconsin) during June and July when predation reaches its seasonal maximum and allochthonous phosphorus supplies are seasonally low. The impact of predation on four dominant zooplankton species was calculated using statistical models and population estimates. Species were Daphnia galeata, Bosmina longirostris, Cyclops bicuspidatus, and Diaptomus siciloides, which account for over 90% of zooplankton biomass in the lake. Both the quantity of zooplankton consumed and size-selectiveness influence phosphorus availability in the lake's limnetic zone. Phosphorus release rate by zooplankton is inversely related to animal size, and therefore large size-selective predation increases phosphorus released per unit zooplankton biomass. In Lake Wingra bluegill predation changes both size distribution and standing crop of zooplankton, but during June-August any increase in specific release rate is offset by a reduction in biomass, which decreases phosphorus release rate at the system level. Zooplankton were collected weekly in 1972 and monthly in 1973 at 0.5-m depth intervals. Monthly bluegill collections were made by bottom trawling, and stomach contents analyzed to determine zooplankton consumption. (Lynch-Wisconsin)
W79-08897

LEAF LITTER IN GULL LAKE, MICHIGAN, U.S.A.,
Brigham Young Univ., Provo, UT. Dept. of Zoology.
J. R. Barnes, R. Ovink, and K. W. Cummins.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 475-479. 1 fig, 1 tab, 14 ref.

Descriptors: *Litter, *Leaves, *Gull Lake(MI), *Degradation(Decomposition), *Depth, *Shredders, Organic matter, Michigan, Lakes, Metabolism, Hickory, White oak, Eutrophication, Leaching, Water temperature, Amphipoda, Hyalella azteca, Gastropods, Chironomidae, Copepods, Ostracoda, Physa, Pycnopsyche, Caddisflies, Aquatic animals, Invertebrates.

Processing of five-g packs of hickory (Carya glabra) and white oak (Quercus alba) leaves anchored at depths of 2.5, 6.0, and 12.0 m in large, eutrophic Gull Lake, Michigan, was investigated 72-85 days, April-July 1975, with sampling every 300 degree days. Dissolved organic matter leaching was the same for each species at each depth despite differing mean temperatures of 19 C at 2.5 m, 17 C at 6.0 m, and 9 C at 12.0 m. Hickory leaves lost about 10% more weight due to leaching than did oak leaves at each depth. Hickory was processed faster than oak at both 2.5 and 6.0 m depths,

and was faster for each at 2.5 m than at 6.0 due probably to differences in shredder faunal densities and temperature, and more mechanical breakage at 2.5 m due to greater water movement. Processing rates of both species were similar at the 12.0 m depth and considerably slower than at the other depths, influenced by the lack of shredders. Chironomids were the most abundant organisms at 2.5 and 6.0 m, except between days 40-65 when large numbers of small amphipods (Hyalella azteca) and gastropods were dominant. Presumed shredders included the caddisfly Pycnopsyche sp., the amphipods Gammarus sp. and H. azteca, and the snail Physa sp. None was found at 12.0 m except an occasional amphipod; dominant organisms were chironomids, copepods, and ostracods. Percent ash-free dry wt after 72-85 days was 2% (2.5 m), 20% (6.0 m), and 86% (12.0 m) for hickory, and 47%, 70%, and 88% for oak. (Lynch-Wisconsin)
W79-08898

ROLE OF INVERTEBRATE PREDATION IN STRUCTURING ZOOPLANKTON COMMUNITIES,
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
P. A. Lane.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977, Vol. 20, September 1978, Part 1, p 480-485. 3 tab, 16 ref. NSF GB 33337.

Descriptors: *Zooplankton, *Biological communities, *Invertebrates, *Predation, *Gull Lake(MI), *Eutrophication, *Methodology, *Dyes, Cyclops bicuspidatus, Lakes, Michigan, Fluorescent dyes, Copepods, Cladocera, Mortality, Cannibalism, Size, Daphnia, Diaptomus, Bosmina longirostris, Tropocyclops prasinus, Mesocyclops edax, Leptodora kindtii, Chaoborus, Epischura lacustris, Diaphanosoma leuchtenbergianum.

Predation among zooplankton in the limnetic zone of large, eutrophic Gull Lake, Michigan, is widespread and important. Complex interrelationships among eight predator and nine prey species, determined by fluorescent staining, are described. Predators include Diaptomus oregonensis, D. minutus, Epischura lacustris, Tropocyclops prasinus, Mesocyclops edax, Cyclops bicuspidatus, Leptodora kindtii, and Chaoborus spp. Prey include Daphnia galeata, D. retrocurva, D. dubia, D. longiremis, Diaphanosoma leuchtenbergianum, Bosmina longirostris, Diaptomus spp., T. prasinus, and C. bicuspidatus. With nutrient enrichment C. bicuspidatus has become dominant due in part to its efficient predation dynamics. It readily attacks prey larger than itself, feeds in groups, is cannibalistic, and preys heavily on diaptomids, which may help explain their marked decline. T. prasinus may be a better predator on some cladocerans than C. bicuspidatus but is probably controlled by Cyclops predation. The predators are generalist feeders, consuming a wide variety of prey; notable are T. prasinus, C. bicuspidatus, L. kindtii, and Chaoborus spp. Calanoid copepods generally had lower predation rates than cyclopoids or larger seizers. The major vertibrate planktovore in Gull Lake is the smelt Osmerus mordax. Rhodamine B has been found to be the best fluorescent stain, and freezing the best preservation method. (Lynch-Wisconsin)
W79-08899

EFFECTS OF A HYPOLIMNETIC APPLICATION OF ALUMINUM SULFATE TO A EUTROPHIC LAKE,
Kent State Univ., OH. Dept. of Biological Sciences.
G. D. Cooke, and R. H. Kennedy.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 486-489. 2 fig, 3 tab, 9 ref. EPA R801936.

Descriptors: *Eutrophication, *West Twin Lake(OH), *Alum, *Sediments, *Hypolimnion, *Lake restoration, *Phosphorus, *Water pollution treatment, East Twin Lake(OH), Ohio, Lakes, Glacial lakes, Nutrients, Limiting factors, Nutrient loading, Alkalinity, Water pollution sources, Littoral, Epilimnion, Sorption, Aluminum hydroxide, Flocculation.

Application of alum to the hypolimnion of eutrophic West Twin Lake, northeastern Ohio, in July 1975 successfully lowered total lake phosphorus to one-third the pretreatment high, but continued eutrophic symptoms indicate littoral phosphorus sources are more important than hypolimnetic sediments. Treatment was effective through November 1976 when monitoring was terminated. Continuing net internal phosphorus loading, smaller than expected reduction in epilimnetic phosphorus levels, and persisting high algal standing crop point to significant epilimnetic phosphorus sources, probably including macrophytes, fish, and epilimnetic sediments. Anaerobic sediments in the hypolimnion had very low phosphorus release rates after treatment. In small lakes like West Twin with low limnetic/littoral ratios and protection against large seiches, the littoral is probably the most important internal phosphorus source. Hypolimnetic sediments were thought to be West Twin Lake's primary source of internal phosphorus loading. In cases of excessive allochthonous phosphorus loading alum is unlikely to be effective in reducing eutrophic symptoms. Alum controls sediments phosphorus through the sorptive capacity of the aluminum hydroxide floc formed in alkaline water. The maximum alum dose was applied to WTL, that amount which can be added before residual dissolved aluminum exceeds 0.05 mg Al/l. Adjacent East Twin Lake, untreated, served as control. (Lynch-Wisconsin)
W79-08900

RELATIONSHIP BETWEEN PHOSPHORUS LOADING AND PHYTOPLANKTON STANDING CROPS IN CHAUTAUQUA LAKE, NEW YORK,
State Univ. of New York Coll. at Fredonia. Environmental Resources Center.
T. A. Storch, W. M. Barnard, and W. J. Metzger.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 490-495. 4 fig, 11 ref.

Descriptors: *Chautauqua Lake(NY), *Nutrient loading, *Phosphorus, *Phytoplankton, *Forecasting, *Trophic level, New York, Lakes, Algae, Chlorophyll, Standing crops, Flushing rate, Nutrients, Limiting factors, Nitrogen, Methodology, Analytical techniques, Eutrophication, Mesotrophy, Lake restoration, Water pollution control, Transparency, Secchi disks, Bioassay, Water pollution sources.

A plot summer phytoplankton standing crop (chlorophyll-a) versus annual phosphorus loading in meso-eutrophic Chautauqua Lake, New York, according to Bachmann and Jones (1974) reliably predicted the lake's response to a 40% reduction in phosphorus loading to the northern basin in 1976 through control of industrial discharges. The reduction produced a 44% decline of chlorophyll-a in July-August from 7.3 mg/cu m in 1975 to 4.1 mg/cu m in 1976, compared with a predicted 48% decrease to 3.8 mg/cu m based on the plot. Data indicate that for the lake's more eutrophic southern basin both point and nonpoint phosphorus sources must be controlled to significantly improve water quality. The southern basin has a flushing rate five times higher than that of the northern basin. Bioassays in 1975-76 showed phosphorus was limiting in both basins much of the year, but nitrogen was colimiting July-December and was the major limiting nutrient in the northern basin September-December. Chlorophyll-a levels are 4-7 times higher in the southern basin than in the northern. Bachmann and Jones' generalized plot for 14 U.S., Canadian, and Swedish lakes does not necessarily apply to the individual lakes, and separate prediction lines must be constructed for each lake because of differences in lake flushing rate, amount of phosphorus available to phytoplankton, and interactions between phytoplankton and nutrients. (Lynch-Wisconsin)
W79-08901

INFRARED IMAGERY AND THERMAL TRANSECTS OF ONONDAGA LAKE, NEW YORK,
State Univ. of New York at Buffalo. Dept. of Biology.
K. M. Stewart.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 496-501. 3 fig, 13 ref.

Descriptors: *Onondaga Lake(NY), *Infrared radiation, *Remote sensing, *Thermal transects, *Thermal scanners, *Aerial photography, *Water pollution sources, New York, Lakes, Water temperature, Plumes, Saline lakes, Thermal radiation, Sewage disposal, Industrial wastes, Soda ash, Isotherms, Thermal pollution.

Surface thermal transects and aerial infrared imagery of relatively saline Onondaga Lake, northwest of Syracuse, New York, were used to study disposition of fluid discharges from the Metropolitan Sewage Treatment Plant (MSTP) and the Soda Ash Manufacturing Company (SAMC). Infrared imagery was collected using aircraft equipped with HRB Singer infrared line scanner systems with detectors capable of operation in the 3-5 and 8-14 micron band range, allowing recording of true thermal imagery day or night. Thermal transects were taken lengthwise along a northwest-southeast center line. The MSTP discharges treated sewage from the southeast shore and from an outfall at a depth of 6.1 m some 520 m from shore; SAMC thermal discharges enter the lake nearby. Effects of discharges from both plants were apparent in the images and in the transects, though the latter did not pass directly over either discharge. The most dense input was from Nine Mile Creek waters after entertainment of fluids draining from SAMC waste beds. Transects from March 1969 show irregular isotherms under partial ice conditions, with a prominent subsurface plume from MSTP discharges and a thin heated surface layer, probably from the SAMC. Infrared images from December 1970 show the SAMC thermal plume and the relatively warm discharges from the MSTP. Use of these and other techniques, including satellite imagery, enhance understanding of lake dynamics. (Lynch-Wisconsin)
W79-08902

LONGITUDINAL CHANGES IN THE WATER CHEMISTRY OF LAKE CHAMPLAIN,
Vermont Univ., Burlington. Dept. of Zoology.
M. Potash, and E. B. Henson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 502-506. 3 fig, 8 ref.

Descriptors: *Lake Champlain(NY), *Water chemistry, *Dilution, *Conductivity, *Alkalinity, *Nutrients, Cations, Sodium, Magnesium, Potassium, Calcium, Tributaries, New York, Lakes, Sedimentation, Lake morphometry.

Water chemistry data collected 1965-74 show that a 1969 analysis of a dilution effect observed in Lake Champlain was oversimplified. The consistent decrease in concentrations of several parameters in the 164 km from the southern source to the northern outlet was earlier attributed to dilution by waters of lower concentration entering from the northeasterly regions of Malletts Bay, the Northeast, and Missisquoi Bay. However, new data indicate the dilution effect occurs in the main lake considerably south of the entry of northeastern waters, at Thompson's Point and Reference Station sampling sites, located 80-100 km from the source. A lake becoming more dilute from source to outlet is unusual, especially since the lateral tributaries contribute waters which invariably exceed adjacent lake waters in concentration. Though causes are unknown, it is thought that biological utilization and physicochemical sedimentation are major factors. Decreases in alkalinity and conductivity from origin to outlet were most abrupt in the southern region between Five-Mile Point and Crown Point, and also between Crown Point and Thompson's Point. Calcium, magnesium, and po-

tassium decreased relatively regularly from south to north, with larger decreases in the former two 40-55 km from the source. Sodium increased for the first 40 km, then decreased steadily thereafter. (Lynch-Wisconsin)
W79-08903

ECOLOGY OF A LAKE CHAMPLAIN WETLAND TRANSECT,
Vermont Univ., Burlington. Dept. of Zoology.
E. B. Henson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 507-509. 2 fig, 1 tab.

Descriptors: *Lake Champlain, *Munson's Flats(VT), *Ecology, *Wetlands, *Invertebrates, *Macrophytes, Lakes, Ecosystems, Vermont, Water chemistry, Detritus feeders, Herbivores, Production, Consumption, Distribution, Hirudinea, Chironomidae, Odonata, Snails, Amphipods, Flatworms, Sparganium, Phalaris arundinacea, Scirpus fluviatilis, Potamogeton, Myriophyllum, Equisetum, Zizania aquatica, Wild rice.

A north-south transect 1975-77 through Munson's Flats, a wetland area on the edge of Lake Champlain 16 km north of Burlington, Vermont, showed: (1) Animals were most abundant and had the most taxa in the submergent-floating zone, were least abundant and had fewer taxa in the harsh emergent zone, and were intermediate in the channel draining the wetland into the lake. (2) Primary consumers were the most abundant fauna in the emergent zone (47%). (3) Detritus feeders were the most abundant fauna in the submergent-floating zone (80%) and in the channel (82%). Production in the emergent zone apparently exceeded consumption, with the reverse true in the submergent-floating zone. In the emergent zone 29% of fauna were secondary consumers and 24% detritus feeders, in the submergent-floating zone 8% were primary and 12% secondary consumers, and in the channel 5% were primary and 13% secondary consumers. The emergent zone contained 34 animals in 15 taxa, the submergent-floating zone 682 animals in 19 taxa, and the channel 286 animals in 18 taxa. Invertebrates were collected in wire baskets containing burreed (Sparganium) and left in the wetland for one month. Vegetation was characterized (south to north) by a sloping land for one month. Vegetation was characterized (south to north) by a sloping meadow dominated by reed canary grass (Phalaris arundinacea), which grew down into the water; an area of burreed, river bull rush (Scirpus fluviatilis), Potamogeton, and Myriophyllum south of the channel; and Equisetum and buttonbush north of the channel. Wild rice (Zizania aquatica) was found in 1975 and 1977. (Lynch-Wisconsin)
W79-08904

AN INVESTIGATION OF THE EFFECTS OF PULP AND PAPER EFFLUENT ON THE MACROBENTHIC COMMUNITY IN SOUTHERN LAKE CHAMPLAIN, U.S.A.,
Vermont Dept. of Water Resources, Montpelier.
C. W. Pagel, and C. A. Wade.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 510-513. 2 fig, 5 ref.

Descriptors: *Lake Champlain, *Benthic fauna, *Pulp and paper industry, *Water pollution effects, *Species composition, *Spevies diversity, *Industrial wastes, Lakes, New York, Effluents, Tubificids, Oligochaetes, Polychaeta, Midges, Mayflies, Limnodrilus hoffmeisteri, Pisidium, Hexagenia limbata, Chironomidae, Sphaeriidae, Bioindicators, Succession, Suspended solids, Phosphorus, Biochemical oxygen demand, Aluminum sulfate, Polymers.

Initiation of a new pulp and paper plant in the southern Lake Champlain area (Ticonderoga Bay) in December 1970 with discharges of an effluent averaging 62,370 cu m/day substantially reduced or eliminated about two-thirds of the 50 species of benthic macrofauna of the lake area, while greatly increasing organism density. April densities increased from 1892 organisms/sq m in 1972 to 7304 in 1973 and 42,980 in 1975, then declined to 11,234 in 1977. Prior to 1970 benthic macrofauna was dominated by the mayfly Hexagenia limbata (65%); these were reduced to 16% in 1972, eliminated by 1975, but reappeared again in 1977. Oligochaeta, mainly the immature tubificid Limnodrilus hoffmeisteri, increased from 2% in 1972 to 54% in 1973 and 93% in 1975, falling to 80% in 1977. Chironomidae composed almost half of the population in 1972, but declined to 14% in 1973 and 2% in 1977. Sphaeriidae declined from 18% in 1972 to 2% in 1977. Species diversity was lowest (0.65) in July 1974 when problems were experienced in the treatment facility, and low values also resulted from introduction of alum and polymers to reduce suspended solids in the effluent 1974-76; suspension of such applications in fall 1976 subsequently improved species diversity. The effluent contains an average of 32.4 kg/day phosphorus, 7580 kg/day suspended solids, and 1283 kg/day BOD. Population changes of Procladius, Peloscolex, Pisidium, Sphaerium, Manayunkia, and Chaoborus are also discussed. (Lynch-Wisconsin)
W79-08905

LOW MOLECULAR WEIGHT DISSOLVED ORGANIC MATTER IN FIVE SOFT-WATER ECOSYSTEMS: A PRELIMINARY STUDY AND ECOLOGICAL IMPLICATIONS,
Toledo Univ., OH. Dept. of Biology.
H. L. Allen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 514-524. 3 fig, 2 tab, 18 ref. NSF GB-35374.

Descriptors: *Low molecular weight, *Organic matter, *Eutrophication, *Ponds, *Indicators, *Trophic level, *Ultraviolet radiation, *Primary productivity, Oligotrophy, Mesotrophy, Dystrophy, Post Pond(NH), Golf Course Pond(NH), Occom Pond(NH), Mud Pond(NH), Star Lake(VT), Nutrients, New Hampshire, Vermont, Hardness(Water), Analytical techniques, Stability, Refractivity, Lakes, Aquatic plants, Algae.

Low molecular weight (LMW), organic compounds separated from total dissolved organic matter (TDOM) in four soft-water New Hampshire ponds and one small soft-water Vermont lake were exposed to high-intensity ultraviolet light; results indicated pattern differences in labile and refractory characteristics may be indicators of differences in productivity and trophic state. Cluster patterns revealed by LMW pool size and oxidation potentials differed among the water bodies apparently in relationship to differences in rates of production, transformation, and decomposition of LMW material (<500). Poorly productive Post Pond has a variable-sized total dissolved organic carbon (TDOC) pool related to the large SA/V ratio of the basin and low external inputs; the small LMW fraction is mostly refractory and contributes to suppressed primary productivity. Moderately productive Golf Course Pond receives significant nutrient additions; macrophytes, epiphytes, benthic flora, and open-water populations all contribute to the TDOC pool and to the larger LMW fraction. Eutrophic Star Lake has a high TDOC pool, and its qualitative variable LMW fraction has a relatively large portion of labile compounds. Hypereutrophic Occum Pond has a large TDOC pool, and the LMW pool contains a large labile fraction and may be quantitatively more variable than in Star Lake. Poorly productive Mud Pond has high TDOC levels accompanied by a large LMW fraction consisting mostly of refractory materials. (Lynch-Wisconsin)
W79-08906

SESTON SEDIMENTATION IN MIRROR LAKE, NEW HAMPSHIRE, AND ITS RELATIONSHIP TO LONG-TERM SEDIMENT ACCUMULATION,
Cornell Univ., Ithaca, NY. Langmuir Lab.
R. E. Moeller, and G. E. Likens.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 525-530. 1 fig, 1 tab, 14 ref.

Descriptors: *Mirror Lake(NH), *Seston, *Sedimentation rates, *Cores, *Nutrient budgets, *Estimating, Lakes, New Hampshire, Oligotrophy, Sediments, Gyttja, Palynology, Nutrients, Cycling nutrients, Eutrophication, Infilling, Nitrogen, Phosphorus, Carbon, Magnesium, Sulfur, Calcium.

Three methods are compared for estimating the almost imperceptible sedimentation rate in small, oligotrophic Mirror Lake, New Hampshire: (1) short-term collections of sedimenting seston, (2) dated sediment cores, and (3) nutrient budgets which compute the difference between annual inputs and outputs of the lake. Pollen-dated sediment cores yield long-term rates, while input-output budgets are sensitive to small measurement inaccuracies. Seston sedimentation into collecting jars placed one meter above the gyttja which fills the basin was relatively uniform during the summers of 1973-75, with overall mean 0.69 g dry wt/sq m/day. A mean annual sedimentation rate of 176 g/sq m/yr was calculated for the deep 10-m station by extending summer rates through autumn turnover. Calculated annual deposition of acid-insoluble ash (diatoms and mineral particles primarily) agreed well (93%) with the mean rate since 1900 derived from the core and assumed to be relatively constant. Over the past 70 years sedimentation has been 121 g/sq m/yr. Though dry-matter accumulation has not differed from the precultural state, nitrogen, sodium, potassium, and aluminum have increased significantly. Total dry matter decomposes and is remobilized at a rate of 36%. Chemical elements undergo remobilization from surface sediments at varying rates: N, 69%, P, 62%; C, 50%, Mg 40%; S and Ca, 32%; K, 17%, Al, 14%, and Na, 3%. (Lynch-Wisconsin)
W79-08907

ACIDIFICATION OF MAINE (U.S.A.) LAKES BY ACIDIC PRECIPITATION,
Maine Univ. at Orono. Dept. of Botany and Plant Pathology.
R. B. Davis, M. O. Smith, J. H. Bailey, and S. A. Norton.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 532-537. 2 fig, 19 ref.

Descriptors: *Acid precipitation, *Maine, *Lakes, *Acidic water, *Hydrogen ion concentration, *Water pollution sources, *Baseline studies, Water pollution effects, Alkalinity, Acidity, Environmental effects, Precipitation(Atmospheric), Sampling.

Summer pH in 1368 Maine lakes decreased from an average of 6.85 in 1937 to an average 5.95 in 1974 (an eight-fold increase in acidity), with about 75% of the decrease occurring 1950-60, when precipitation acidity is thought to have increased the most. Data are based on 1936 pH readings taken at the water surface with Wallace-Tiernan colorimetry until the 1960s, and thereafter with portable pH meters; the methods agree within 0.1 pH units. Hydrogen ion concentration increased an estimated average of 1,000,000 M 1937-74 in the lakes. These results are the first demonstration of pH decrease due to acid precipitation in a large U.S. lowland lake region. Because of the relatively moderate decrease in pH no biological effects have been noted in the Maine lakes, but in several Norwegian, Swedish, and Canadian lakes more severe acidification has resulted in severe effects on fish and other biota. Precipitation acidity has generally been greater in western than in eastern or northern Maine, and regional variations in amounts of precipitation and in seasonal patterns of precipitation and runoff have influenced lake pH. To verify overall averages, a subset of the 258 lakes for which there are pH readings for more than one year was analyzed separately. The subset had a mean alkalinity of 11.4 + or - 12.6 ppm as CaCO3 and a maximum of 88 ppm, typical of the entire data set. (Lynch-Wisconsin)

W79-08908

PALEOLIMNOLOGIC EVIDENCE FOR INCREASED ZINC LOADING IN LAKES OF NEW ENGLAND, U.S.A.,
Maine Univ. at Orono. Dept. of Geological Sciences.
S. A. Norton, R. F. Dubiel, D. R. Sasseville, and R. B. Davis.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 538-545. 3 fig, 1 tab, 22 ref.

Descriptors: *New England, *Lakes, *Zinc, *Cores, *Paleolimnology, *Sedimentation, *Heavy metals, Acid precipitation, Palynology, Water pollution sources, Trophic level, Geology, Hydrogen ion concentration, Alkalinity, Sedimentation rates, Annabessacook Lake(ME), China Lake(ME), Long Pond(ME), Maranacook Lake(ME), Moosehead Lake(ME), Sebasticook(ME), Sebago Lake(ME), Seymour Lake(VT), Columbia Lake(CT), Granite Lake(NH), Lashaway Lake(MA), Beach Pond(CT-RI).

Chemical analysis of pollen-dated sediment cores from 12 New England lakes showed zinc content in the lakes had grown much higher in the past two centuries, regardless of morphology, trophic status, or activities in the drainage basin. An initial increase was noted in sediments deposited about 1800-1900 A.D., and a second about 1910-20. The first increase is attributed to atmospheric precipitation, and the second to widespread introduction of galvanized metal into the drainage basin. Zinc is transported to the lakes and sedimented (particulates), chemically absorbed on iron-manganese oxides, or precipitated as a sulfide within the sediment. Sebasticook Lake, Maine, has been grossly loaded with zinc over the past 30 years from zinc sulfate derived from herbicides. It is possible that floral and faunal changes evident in the recent paleolimnological record were caused by increased flux of zinc and other heavy metals associated with acid precipitation, rather than to climatic changes or point sources as has been thought. Cores were taken from Annabessacook, China, Maranacook, Moosehead, Sebasticook, and Sebago Lakes, and Long Pond, Maine; Columbia Lake, Connecticut; Granite Lake, New Hampshire; Lashaway Lake, Massachusetts; Seymour Lake, Vermont; and Beach Pond, Connecticut-Rhode Island. The lakes range from oligotrophic to eutrophic, have maximum depths of 6.1-96.5 m, and their alkalinity varies from 6-29 ppm CaCO3. The cultural-precultural boundary was taken as the rise of weed pollen (Ambrosia and Rumex). (Lynch-Wisconsin)
W79-08909

RESPONSE OF A SOFT WATER LAKE IN NORTH FLORIDA, U.S.A., TO INCREASED CHEMICAL AND PARTICULATE LOADING FROM ITS WATERSHED,
Michigan State Univ., East Lansing. Inst. of Water Research.
T. M. Burton, R. R. Turner, and R. C. Harriss.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 546-549. 8 ref.

Descriptors: *Lake Jackson(FL), *Watersheds(Basins), *Water pollution sources, *Nutrient budgets, *Water pollution effects, *Urbanization, Lakes, Florida, Hardness(Water), Phosphorus, Nitrogen, Chlorides, Silicon, Particulates, Urban runoff, Water chemistry, Fisheries, Largemouth bass, Micropterus salmoides, Tributaries, Alkalinity, Conductivity, Eutrophication, Phytoplankton, Algae.

Nutrient budgets for Lake Jackson, in northern Florida, indicate that urbanization has substantially increased phosphorus inputs and reduced silicon inputs, and suburbanization has markedly increased nitrogen inputs. Urban development on two arms of the lake has significant reduced water quality locally, and continued urban development in the watershed is likely to degrade water quality in the entire lake to the point of destroying the largemouth bass (Micropterus salmoides) fishery. Budgets were constructed for inputs of phosphorus, inorganic nitrogen, chloride, silicon, and particulate matter to the 1515-ha closed-basin lake, based on unit-area loadings derived from three representative subwatersheds, selected sampling of all tributary streams, and the amount and chemical composition of precipitation. Adverse changes in water quality have included increases in alkalinity (from four to over 50 mg/l CaCO3), specific conductance (from 27 to over 100 micromhos/cm), phytoplankton production (from an average of 32 mg C/cu m/hr to 147 mg), molybdate reactive phosphorus (from two to 23 microg P/l), and winter nitrate and ammonia concentrations, and highly increased sedimentation rates. The subwatersheds represented urban, suburban, and mixed forest-agriculture. Total phosphorus inputs to the lake were 12,930 kg/yr, 4% derived from rain and the rest from runoff, of which 49% was from urban areas. Of inorganic nitrogen, 66% (3305 kg/yr) was derived from rainfall. (Lynch-Wisconsin)
W79-08910

BIOLOGICAL LAYERING RESULTING FROM EXTREME MEROMICTIC STABILITY, DEVIL'S HOLE, ABACO ISLAND, BAHAMAS,
State Univ. of New York at Buffalo. Div. of Biology.
K. H. Goehle, and J. F. Storr.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 550-555, 4 fig, 1 tab.

Descriptors: *Devil's Hole(Bahama Islands), *Solution holes, *Meromixis, *Water chemistry, *Biological communities, *Chemocline, Pigments, Bacteria, Sulfur bacteria, Lakes, Caves, Bahama Islands, Food chains, Mixolimnion, Salinity, Water temperature, Dissolved oxygen, Stability, Phytoplankton, Algae, Zooplankton, Chlorophyll.

The chemocline of Devil's Hole and small, very stable meromictic lake on Greater Abaco Island, Bahama Islands studied 1965-74, contains many organisms with similar pinkish pigmentation, and there is a strong interrelationship between the biological community and the chemistry of the layer. The solution hole, though inland, has a connection to the sea, and is nearly circular, 24-30 m in diameter and 50 m deep; water in the upper 15 m is primarily fresh. The chemocline at a depth of about 15-21 m is unique in having major differences in concentrations of several chemicals compared with higher and lower layers. Major biological activity in the chemocline occurs 15-18 m, coinciding with a temperature peak at 18 m and an oxygen peak at 16 m. Maximum salinity occurs 17-22 m. The thermal increase in the chemocline is believed due to a greenhouse effect or to activity of the bacterial plate, probably composed of Chlorobium, Chromatium, and Thiocystis, green and red sulfur bacteria. Bacterio-chlorophyll-d and accessory pigments give cells a reddish-brown to magenta-pink color, which zooplankton take on by ingesting the bacteria, and the mysid Eurthrops elegans from ingesting zooplankton. Rainout from the biologically rich mixolimnion apparently supplies nutrients to chemocline organisms. The mixolimnion contains diatoms and other phytoplankton, zooplankton, crabs, small fish, and large diving beetles. (Lynch-Wisconsin)
W79-08911

ANALYSIS OF FIVE NORTH AMERICAN LAKE ECOSYSTEMS, I. A STRATEGY FOR COMPARISON,
Wisconsin Univ.-Madison. Dept. of Botany.
O. L. Loucks, and W. E. Odum.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 556-561, 6 tab, 12 ref. NSF DEB 76-82283.

Descriptors: *Findley Lake(WA), *Marion Lake(BC-Canada), *Mirror Lake(NH), *Lawrence Lake(MI), *Lake Wincra(WI), *Limnology, *Baseline studies, Lakes, Ecosystems, Hydraulic residence time, Nutrient loading, Nutrient budgets, Nutrients, Phosphorus, Nitrogen, Lake morphology, Watersheds(Basins), Water chemistry, Land use, Geology, Hydrogen ion concentration, Canada, Washington, New Hampshire, Michigan, Wisconsin.

This paper introduces an eight-part comparative limnological study of five mostly similar U.S. and Canadian lakes representing a variety of hydrological, chemical, and biological characteristics. The study focused on the flux of materials between land and lake, and their processing in the lake. The lakes, which included Findley (Washington), Marion (British Columbia), Mirror (New Hampshire), Lawrence (Michigan) and Wingra (Wisconsin), were similar in latitude (42-49 degrees N), size (5-15 cu m in area except Wingra, 137 cu m but shallow), and altitude (213-300 m, except Findley at 1200 m). All were dimictic except polymictic Marion. Differences in basin, physical and morphological, and chemical characteristics yielded a series of treatments or gradients. The comparative approach adopted provides a more rigorous means of evaluating processes and controls in lake ecosystems. Differing variables included basin size (34-13,000 ha), average annual rainfall (80-270 cm), annual hydrologic inflow (41-57 million cu m), renewal time (0.014-1.0 yrs), maximum depth (6-27 m), and proportion of lake in littoral (almost none to large). Chemistry varied as a function of substrate geology, vegetation, and land use; calcareous Lawrence and Wingra had high pH (7.4-8.5), total alkalinity (100-250 mg/l), ammonium (10-1000 mg/cu m), and nitrate nitrogen (1-2500 mg/cu m). Total phosphorus loadings ranged from 0.15-0.96 g/sq m/yr, and Marion and Wingra had high organic inputs. (Lynch-Wisconsin)
W79-08912

ANALYSIS OF FIVE NORTH AMERICAN LAKE ECOSYSTEMS. II. THERMAL ENERGY AND MECHANICAL STABILITY,
Dartmouth Coll., Hanover, NH. Dept. of Earth Sciences.
N. M. Johnson, J. S. Eaton, and J. E. Richey.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 562-567, 2 fig, 1 tab, 6 ref.

Descriptors: *Lakes, *Stability, *Energy, *Heat budget, *Thermodynamics, Advection, Convection, Heat transfer, Water temperature, Water circulation, Latent heat, Heat, Computer programs, LIMNO, Algorithms, Classification, Birgean work, Winds, Schmidt stability, Flushing rate, Findley Lake(WA), Marion Lake(BC-Canada), Mirror Lake(NH), Lawrence Lake(MI), Lake Wingra(WI), Baseline studies.

Five standard energy parameters--annual heat budget, mean annual temperature, Birgean wind work (B), Schmidt stability (S), and water renewal--together provide a practical and useful technique for describing lake energy characteristics, demonstrated with five Canadian and U.S. lakes. A general algorithm, LIMNO, utilizes a computer to calculate annual heat budget, Schmidt stability, and Birgean work. B is the amount of mechanical work exerted on or by a lake through its surface to produce the observed density distribution, and S is the subsequent amount of work needed to mix the lake to uniform density without gaining or losing heat. Lakes studied were Findley (Washington), Marion (British Columbia), Mirror (New Hampshire), Lawrence (Michigan), and Wingra (Wisconsin). Conclusions: (1) Wingra and Marion are one order of magnitude less stable (10- g-cm/sq cm) than Findley, Lawrence, and Mirror (100 g-cm/sq cm); (2) Mirror and Lawrence are virtually identical in overall thermal and convective regimes; (3) in Findley, the coldest lake, latent heat is the dominant term in the heat budget; (4) though winter stability is uniformly low for all lakes (S 10 g-cm/sq cm), ice cover prevents exertion of B on the water column; (5) advection dominates Marion circulation (about 76 renewals/yr) compared to Wingra, Lawrence, and Mirror (1-2 renewals/yr);

and (6) Mirror is the most stagnant. (Lynch-Wisconsin)
W79-08913

ANALYSIS OF FIVE NORTH AMERICAN LAKE ECOSYSTEMS. III. SOURCES, LOADING AND FATE OF NITROGEN AND PHOSPHORUS,
Cornell Univ., Ithaca, NY. Dept. of Ecology and Systematics.
G. E. Likens, and O. L. Loucks.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 568-573, 6 tab, 6 ref.

Descriptors: *Nitrogen, *Phosphorus, *Nutrient budgets, *Water pollution sources, *Path of pollutants, *Lakes, Nutrient loading, Nutrients, Cycling nutrients, Forest watersheds, Watersheds(Basins), Metabolism, Ecosystems, Sediments, Tributaries, Streams, Precipitation(Atmospheric), Particulates, Flushing rate, Land use, Findley Lake(WA), Mirror Lake(New Hampshire), Lake Wingra(WI), Washington, New Hampshire, Wisconsin, Litter, Baseline studies.

Study of nitrogen and phosphorus budgets in Findley Lake (Washington), Mirror Lake (New Hampshire), and Lake Wingra (Wisconsin) showed that: (1) nutrient input levels generally reflected land use, watershed area, vegetation, and geology; (2) precipitation inputs were significant and sometimes dominant; (3) lacustrine sediments were a sizable sink for nitrogen and phosphorus; (4) retention times for nitrogen and phosphorus may be determined by factors other than water renewal time; and (5) insect emergence may account for significant loss of nitrogen and phosphorus from lake ecosystems. Patterns of short-term nutrient loading and losses need further study at the ecosystem level. Data were not sufficient to test the hypothesis that lakes in forested watersheds receive the majority of their inputs of nitrogen and phosphorus from direct precipitation and gases, whereas runoff dominates in open grassland or disturbed watersheds. Data for Findley were from 1975, for Wingra averages from 1970-74, and for Mirror averages from 1968-75. Wingra is located in a grassland area and receives urban drainage from Madison, Wisconsin, while Findley and Mirror have forested watersheds. Wingra had by far the largest inputs of phosphorus (0.96 g/sq m/yr) and nitrogen (23.59 g/sq m/yr), but among the lakes proportions added from precipitation, fluvial, and litter sources were remarkably similar. Evapotranspiration was much more important than drainage area size in determining annual fluvial water input to the lakes. (Lynch-Wisconsin)
W79-08914

ANALYSIS OF FIVE NORTH AMERICAN LAKE ECOSYSTEMS. IV. ALLOCHTHONOUS CARBON INPUTS,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
W. E. Odum, and R. T. Prentki.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 574-580, 5 fig, 16 ref.

Descriptors: *Carbon, *Water pollution sources, *Lakes, *Nutrient loading, *Watersheds(Basins), *Tributaries, Lake Wingra(WI), *Findley Lake(WA), Marion Lake(BC-Canada), Mirror Lake(NH), Lawrence Lake(MI), Nutrient budgets, Physical properties, Hydraulic residence time, Particulates, Organic loading, Streams, Particulate organic carbon, Dissolved organic carbon, Litter, Precipitation(Atmospheric), Vegetation, Shores, Baseline studies.

The amount and importance of allochthonous organic carbon inputs to five small North American lakes were controlled primarily by fluvial input, in turn influenced by watershed-lake area ratios, annual precipitation, watershed runoff, and presence or absence of permanent inlet streams. In general, allochthonous carbon is probably most important in carbon budgets of small oligotrophic lakes with relatively large watersheds and moderate-to-high annual precipitation. With short lake retention time much of the allochthonous carbon may be flushed through the system. Secondary factors influencing inputs are shoreline development and length of forested shoreline. Heterotrophic lakes are most likely to exist where autochthonous production is severely limited by physical or chemical factors. Lakes studies were Findley Lake (Washington), Marion Lake (British Columbia, Canada), Mirror Lake (New Hampshire), Lawrence Lake (Michigan), and Lake Wingra (Wisconsin). When fluvial inputs were high, dissolved organic carbon (DOC) tended to exceed particulate organic carbon (POC). Litter input of organic carbon was of secondary importance, influenced by length of wooded shoreline and type of vegetation. Precipitation was also a secondary source of organic carbon, but factors affecting the amount of such inputs are unknown. Although Marion Lake has an extremely high fluvial input of organic carbon, its short retention time results in a relatively low net allochthonous input. Deepening the lake, thereby increasing retention time, would radically alter this input. (Lynch-Wisconsin)
W79-08915

ANALYSIS OF FIVE NORTH AMERICAN LAKE ECOSYSTEMS. V. PRIMARY PRODUCTION AND COMMUNITY STRUCTURE,
Washington Univ., Seattle. Fisheries Research Inst.
A. H. Devol, and R. C. Wissmar.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 581-586, 2 fig, 2 tab, 22 ref.

Descriptors: *Lakes, *Model studies, *Primary productivity, *Nutrient loading, *Phosphorus, *Flushing rate, Phytoplankton, Macrophytes, Epiphytes, Biological communities, Ecosystems, Findley Lake(WA), Marion Lake(BC-Canada), Mirror Lake(NH), Lawrence Lake(MI), Lake Wingra(WI), Nitrogen, Nutrients, Vollenweider models, Mathematical models, Algae, Depth, Periphyton, Trophic level, Cycling nutrients, Sediments, Baseline studies.

Total primary productivity and especially phytoplankton productivity in five small North American lakes appeared related to total phosphorus loading, modified by flushing rate, but factors regulating production by macrophytes and periphytes were obscure. Lakes studied were Findley (Washington), Marion (British Columbia, Canada), Mirror (New Hampshire), Lawrence (Michigan), and Wingra (Wisconsin). One reason the total phosphorus loading-flushing rate approach fails to completely explain total productivity is because it neglects significant phosphorus pools and cycling within the lake ecosystem itself. Phosphorus concentrations in sediments are generally much higher than in overlying water, and in the short run are not directly dependent on total loading. Furthermore, both macrophytes and epiphytic algae effectively extract phosphorus from sediments, whereas phytoplankton are entirely dependent on water column phosphorus levels, largely a function of external loading. For the five lakes phytoplankton production was a better parameter than total production for establishing a relationship with phosphorus loading and flushing rate. Vollenweider's 1968 loading-mean depth model classifies oligotrophic Marion and Findley Lakes as eutrophic due to omission of the lakes' high flushing rates. Dillon's corrected model (1975) incorporating both flushing rate and phosphorus retained in the lake correctly predicts trophic status of all lakes except Marion. (Lynch-Wisconsin)
W79-08916

ANALYSIS OF FIVE NORTH AMERICAN LAKE ECOSYSTEMS. VI. CONSUMER COMMUNITY STRUCTURE AND PRODUCTION,
Washington Univ., Seattle. Fisheries Research Inst.
R. C. Wissmar, and R. G. Wetzel.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 587-597, 2 fig, 3 tab, 20 ref. NSF DEB 76-82283.

Descriptors: *Carbon, *Zooplankton, *Fish, *Benthic fauna, *Insects, *Lakes, *Productivity, *Food habits, *Ecosystems, Findley Lake(WA), Marion Lake(B.C.-Canada), Mirror Lake(NH), Lawrence Lake(MI), Lake Wingra(WI), Faunal lists, Detritus, Carnivores, Herbivores, Habitats, Ecology, Niches, Invertebrates, Nutrient budgets, Carbon cycles, Baseline studies.

The potential influence of autochthonous and allochthonous organic carbon sources upon invertebrate and vertebrate consumer community structure and production was investigated in five North American lakes, Findley (Washington), Marion (British Columbia, Canada), Mirror (New Hampshire), Lawrence (Michigan), and Wingra (Wisconsin). Zooplankton, insects, and fish were considered, and a list of major species with feeding modes and preferred habitats is given. Conclusions: (1) detrivorous invertebrates were the most important consumers in all five lakes, and in more productive systems with high phytoplankton production there were increased levels of zooplankton production relative to insect production; (2) fish communities of the more-productive ecosystems (Lawrence, Wingra) showed stronger niche complementarily due to segregation by habitat and food size; these lakes and more diverse and productive vegetative habitats that supported prey organisms of high abundance, availability, and diversity; (3) low zooplankton and insect turnover rates in less-productive lakes may have been due to less energy being utilized for production as a result of greater respiratory and maintenance costs; and (4) low trophic transfer efficiencies in the more-productive ecosystems implies a greater diversion of energy to benthic communities. (Lynch-Wisconsin)
W79-08917

ANALYSIS OF FIVE NORTH AMERICAN ECOSYSTEMS. VII. SEDIMENT PROCESSING,
Connecticut Univ., Storrs. Biological Sciences Group.
P. H. Rich, and A. H. Devol.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 598-604, 2 fig, 2 tab, 13 ref.

Descriptors: *Sediments, *Degradation(Decomposition), *Carbon dioxide, *Oxygen, *Respiratory quotient, *Organic matter, *Energy conversion, Lakes, Findley Lake(WA), Marion Lake(BC-Canada), Mirror Lake(NH), Lawrence Lake(MI), Lake Wingra(WI), Trophic level, Metabolism, Respiration, Methodology, Analytical techniques, Oxidation-reduction potential, Electron transport, Microorganisms, Thermodynamics, Baseline studies.

Respiratory quotients (RQ), the ratio of carbon dioxide produced to oxygen removed, were derived for organic matter decomposition in sediments of five small North American lakes: Five small North American lakes were studied, Findley (Washington), Marion (British Columbia, Canada), Mirror (New Hampshire), Lawrence (Michigan), and Wingra (Wisconsin). In well-oxygenated lakes RQ is near unity and anaerobic respiration is tightly coupled to aerobic. Lakes not well oxygenated have RQs significantly < 1, and important amounts of potential energy are diverted from biota through alternate electron acceptors (anaerobic microbial respiration) and have a direct thermodynamic impact on lake inorganic chemistry (benthic detrital electron flux). RQs significantly < 1 indicate the lake is returning energy to the biota as the oxidation of reduced products is assisted by lithography and primitive photosynthesis. Despite contrary trophic level indicators, both Mirror and Findley Lakes experienced brief periods of intense metabolism which placed critical demands on total aphotic zone capacity to accept electrons. In eutrophic Wingra and Lawrence,

RQs indicate more chronic electron accepter limitation. The phenomenon of excess CO2 production suggests the ideal RQ of 0.85 is not likely among prokaryotes where terminal oxygen reduction is not closely linked to carbon oxidation. (Lynch-Wisconsin)
W79-08918

ANALYSIS OF FIVE NORTH AMERICAN LAKE ECOSYSTEMS. VIII. CONTROL MECHANISMS AND REGULATION,
Michigan State Univ., Hickory Corners. W. K. Kellogg Biological Station.
R. G. Wetzel, and Richey.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 605-608. 1 tab, 9 ref.

Descriptors: *Lakes, *Respiration, *Organic matter, *Flushing rate, *Primary productivity, *Degradation(Decomposition), *Carbon cycle, Metabolism, Findley Lake(Washington), Marion Lake(B.C.-Canada), Mirror Lake(New Hampshire), Lawrence Lake(Michigan), Lake Wingra(Wisconsin), Carbon, Catabolism, Thermodynamics, Stratification, Littoral, Macrophytes, Algae, Phytoplankton, Regulation, Sediments, Sedimentation, Nutrient budgets, Succession, Baseline studies, Ecosystems, Food habits.

Input, degradation, and output functions were compared in five temperate-zone North American lakes, Findley (Washington), Marion (British Columbia, Canada), Mirror (New Hampshire), Lawrence (Michigan), and Wingra (Wisconsin). Several consistencies emerged from the eight-part study: (1) Very high renewal rates (flushing rates) resulted in loading (little organic) remaining in the basin long enough for effective degradation, and loss by outflow occurred regardless of the optimality of substrates or environmental conditions for decomposition. (2) Lack of stratification (low thermal stability) coupled with low renewal rates led to reduction of anaerobic conditions (due to constant resuspension) and maximum organic degradation. (3) Shifts to increasing autochthonous productivity by littoral flora in dimictic lakes resulted in progressively greater respiratory decomposition in sediments. (4) In lakes of moderate depth, phytoplanktonic decomposition occurred largely in the water column, shifting increasingly to sediments with decreasing mean depth. (5) Increasing dominance of organic matter loading by emergent littoral macrophytes led to greater inputs of refractory organic compounds, and greater anaerobic decomposition in sediments, higher respiratory quotients, and accelerated sedimentation. (6) Increasing productivity and accumulated organic matter shifted consumer dominance from allochthonous detritivores to zooplankton and autochthonous detritivores. (Lynch-Wisconsin)
W79-08919

PHYSIOGRAPHY OF LAKE LINNEVATN, WESTERN SPITSBERGEN,
Oslo Univ., Norway. Dept. of Limnology.
A. Boyum, and J. Kjensmo.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 609-614. 2 fig, 3 tab, 6 ref.

Descriptors: *Lake Linnevatn(Norway), *Physiography, *Hydrography, *Heat budget, *Ice cover, *Sulfates, *Glacial lakes, *Polar regions, Lakes, Norway, Spitsbergen(Norway), Meteorology, Water temperatures, Ions, Melt water, Geology, Gypsum, Conductivity, Magnesium, Calcium.

The meteorology, hydrography, and ionic composition of the water of Lake Linnevatn, a glacial lake in western Spitsbergen, Norway, are described, based on 1968 data. Lake Linnevatn behaves thermally like a true polar lake because: (1) high amounts of heat are required to melt the relatively thick ice cover and overlying snow, and the lake is sheltered from the most-intense solar radiation; and (2) the lake continuously receives considerable quantities of cold glacial melt water during thaw, which greatly reduces heat storage. Maximum water temperature was three C on 27 August. The ice cover disappeared on 13 August, abnormally late due to significantly lower-than-average mean water temperatures throughout the year. Vertical water temperature series taken on 17, 20, and 27 August showed lake heat contents of 2404, 2200, and 1864 cal/sq cm, based on four C. Heat income for the period accordingly was 540 cal/sq cm. The lake can be characterized as typically sulfated; sulfates constitute about 60% of total milliequivalents of anions in the water. Calcium is the dominant cation, and magnesium content is high. These three components are derived from rocks in the lake's catchment, specifically gypsum. Lake water is fairly rich in soluted salts. Specific conductivity averaged 181 x 18-units, but was relatively poor in electrolytes compared with Lake Kongressvatn, which averaged 512 x 18 units. (Lynch-Wisconsin)
W79-08920

LAKES OF POLAR REGIONS--AGE, COMPLEXITY, AND TROPHIC STATE,
Naturhistoriska Riksmuseet, Stockholm (Sweden). Section for Invertebrate Zoology.
C. Holmquist.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977, Vol. 20, September 1978. Part 1, p 615-617, 16 ref.

Descriptors: *Polar regions, *Lakes, *Trophic level, *Age, *Alaska, *Arctic, *Classification, Polar lakes, Greenland, Glacial lakes, Siberia(U.S.S.R.), Lake Hazen(Canada), Nettilling Lake(Canada), Lake Peter(AK), Lake Schrader(AK), Benthic fauna, Lake Imikpuk(AK), Plankton, Canada, Lake Linnevatn(Norway), Lake Kongressvatn(Norway), Norway, Cold regions.

An assumption that arctic lakes are young, poor in nutrients and therefore oligotrophic, and biologically simple is not accurate for all such lakes, or even for the average arctic lake. Few world lakes fit the definition of 'polar lakes' (having water temperatures never exceeding 4 C); Lake Hazen of Ellesmere Island, Canada, may be one example, and Lakes Linnevatn and Kongressvatn of Spitsbergen, Norway, are borderline. Polar lakes hardly exist in Alaska and are scarce in Greenland and Siberia. Only a few deep lakes from formerly glaciated areas have been used to support the simplistic definition, including Lake Hazen, Nettilling Lake, and other Canadian lakes, and Lakes Peter and Schrader of Alaska's eastern Brooks Range. Lake Imikpuk (Barrow, Alaska) has also been cited, but it is hardly typical as it is located on the sandy shore of the ocean, and has been flooded at least once by ocean water and then subjected to man-controlled freshening. Alaskan lakes often reveal not only considerable diversity and richness of benthic invertebrates, but often also a lack of consistency between water quality, plankton, and benthic fauna. This suggests a need for caution in classifying a lake's trophic status on the basis of physico-chemical and planktonic properties. Though lakes from glaciated areas are no older than the retreat of the ice, in unglaciated regions lakes may be much older. (Lynch-Wisconsin)
W79-08921

CORRELATION BETWEEN EXCHANGEABLE PHOSPHORUS AND SEDIMENTARY PIGMENT IN SOME IRISH LAKES,
Dundalk Regional Technical College, County Louth (Ireland). Science Dept.
D. J. Douglas, D. A. Murray, M. Halliday, and J. Greene.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 618-623. 2 fig, 2 tab, 15 ref.

Descriptors: *Ireland, *Lakes, *Pigments, *Phosphorus, *Bioavailability, *Sediments, *Eutrophication, *Trophic level, Lough Ennell(Ireland), Lough Gowna(Ireland), Lough Muckno(Ireland), Lough Ramor(Ireland), Lough Key(Ireland), Iron, Cores, Chlorophyll, Carotenoids, Primary productivity, Nutrients, Exchangeable phosphorus, Algae, Phytoplankton, Mud.

Pigment levels and the exchangeable phosphorus fraction in one-m sediment cores generally correlated well in a study of five eutrophic lakes in the Irish midlands, except in shallow Lough Ramor where submerged aquatic vegetation appears to remove large quantities of phosphorus from sediments, and in Lough Key and the north basin of Lough Gowna where significant iron levels may cause rapid phosphorus precipitation. In addition, Gowna's north basin has low levels of primary production and phosphorus. In Loughs Ennell, Gowna (south basin), and Muckno, all subject to artificial enrichment and showing increases in eutrophication, there was remarkable similarity between exchangeable phosphorus levels and pigment concentrations. The lakes in which this correlation was not evident showed little indication of increased eutrophication. Chlorophyll derivatives and total carotenoids were taken to reflect changing production, with low ratios between the two indicating eutrophic conditions with allochthonous production prevailing, and high ratios indicating greater proportional inputs of allochthonous material. Loughs Ennell and Muckno are highly eutrophic, Lough Key eutrophic, Lough Ramor enriched, and Lough Gowna tends toward eutrophic conditions, especially in the south basin. Exchangeable phosphorus appears to approximate the fraction of phosphorus available to algae at the time of sediment deposition. (Lynch-Wisconsin)
W79-08922

BIOSTRATIGRAPHICAL EVIDENCE FOR VARIATIONS IN THE RECENT PATTERN OF SEDIMENT ACCUMULATION IN LOUGH NEAGH, N. IRELAND,
University Coll., London (England).
R. W. Battarbee.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 624-629. 4 fig, 9 ref.

Descriptors: *Lough Neagh(N. Ireland), *Biostratigraphy, *Bottom sediments, *Palynology, *Paleolimnology, *Deposition(Sediments), Micropaleontology, Sediments, Cores, Diatoms, Algae, Resuspension, Stratigraphy, Northern Ireland, Lakes, Lake morphology, Sedimentation rates.

Strong differences in accumulation rates both among cores at the same sampling location and within cores in flat-bottomed Lough Neagh, Northern Ireland, indicate that in the absence of sediment surface micro- and macromorphometry it is impossible to locate sites with a predictable history of accumulation or stratigraphy within the lake's profundal zone. Moreover, since there are no clearly defined lithostratigraphic changes in the upper three meters it is impossible to recognize a particular core type in the field. A core's stratigraphic record can only be assessed through independent dating of each core or microfossil analysis and correlation with dated cores. If sediment is constantly being redistributed, causing areas of high and low accumulation rates, net sediment losses may occur, and apparently slow accumulation in a given core may be as much a result of intermittent accumulation phases as of slow but continuous accumulation. An inverse relationship between microfossil concentration (e.g., diatoms) and sediment accumulation rate cannot be assumed, because of the possibility of sediment redistribution rather than influx of allochthonous matter. Cores were taken 1969-1973 in the Battery area, Antrim Bay, and the Trench. Undetected variations in sediment surface features may affect the accumulation rates. Cores with intermediate accumulation rates were scarce or absent. (Lynch-Wisconsin)
W79-08923

CARBOHYDRATE CONTENT AS AN ECOLOGICAL TOOL IN THE STUDY OF PLANKTONIC BLUE-GREEN ALGAE,

Ministry of Agriculture, Antrim (Northern Ireland). Freshwater Biological Investigation Unit.
C. E. Gibson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977, Vol. 20, September 1978. Part 1, p 630-635, 3 fig, 1 tab, 8 ref.

Descriptors: *Cyanophyta, *Carbohydrates, *Analytical techniques, *Phytoplankton, *Limiting factors, *Lough Neagh(Northern Ireland), Algae, Lakes, Northern Ireland, Oscillatoria agardhii, Stephanodiscus astraea, Melosira italica subarctica, Diatoms, Chrysophyta, Chlorophyll, Pseudoanabaena, Water temperature, Bioassay, Methodology, Ecology, Nutrients, Nitrogen, Phosphorus, Darkness, Respiration.

The use of anthrone-reactive carbohydrate content of planktonic cyanophytes in studying the previous light history of lake planktonic algae (and their movement through the water column), cell nutrition, and dark respiration rate is illustrated with field and laboratory data for Lough Neagh, Northern Ireland, January-June 1977. Carbohydrate content of blue-green algae rises in response to light incubation and nutrient deficiency, and falls in darkness. With nutrient sufficiency carbohydrate content and dark respiration rate show close positive correlation. Striking resemblance was found between water temperature and carbohydrate profiles 1-2 June in Antrim Bay, when a temperature gradient was changed by winds which stirred warm water downward. Since cell carbohydrate content is predictable, a cell must be able to control it. A natural phytoplankton population of the dominant diatoms Stephanodiscus astraea and Melosira italica subarctica, and the cyanophyte Oscillatoria agardhii was incubated in light at eight C for 25 hrs; carbohydrate content rose rapidly during the first five hours, then slowed to an equilibrium level of 48-50 mg carb/mg chl-a. Darkness produced the reverse effect. Nitrogen or phosphorus starvation produces higher carbohydrate levels which do not decline rapidly until the deficient nutrient is added. This effect could be used in a rapid assay of nitrogen or phosphorus deficiency. Some carbohydrate loss in the dark is due to transformation to protein, but much is respired causing considerable changes in cell dry weight. (Lynch-Wisconsin)
W79-08924

RESPONSE OF SOME BRITISH LAKES TO PAST CHANGES IN LAND USE ON THEIR CATCHMENTS,
Freshwater Biological Association, Cumbria (England).
W. Pennington.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 636-641, 2 fig, 2 tab, 9 ref.

Descriptors: *Lakes, *United Kingdom, *Organic matter, *Land use, *Deposition(Sediments), *Paleolimnology, Deforestation, Seston, Sediments, Sedimentation rates, Carbon, Nitrogen, Phosphorus, Potassium, Nutrients, History, Palynology, Urbanization, Agriculture, Hubbard Brook(UK), Loch Clair(Scotland), Ennerdale Water(England), Blelham Tarn(England), Radioactive dating, Eutrophication.

Present annual sediment deposition rates for 13 British lakes are compared with historical evidence based on palynology and radioactive dating. Inputs of carbon, nitrogen, phosphorus, and potassium were calculated from the position of the 1963 horizon, determined by distribution curves for fallout of cesium-137. Analysis per unit wet volume of 1963 and overlying sediments in contiguous one-cm slices provided an estimate of mean annual deposition over unit area, which differed between lakes as much as 20-fold, greatly exceeding between-lake differences for any element relative to either dry weight or wet volume. Highest sediment accumulation rates were found in lakes with the highest nitrogen and phosphorus levels in surface sediments, highest population density, and summer hypolimnion oxygen deficiency. Between-lake differences appear to be of recent origin and related to enrichment, based on comparative data for the last 150 years derived from lead-210 dating. Evaluations are also presented for the entire postglacial period. Loch Clair, an acid, unproductive lake in northwest Scotland, is in a nearly natural state with an undisturbed forest catchment. A historical organic matter deposition rate of 5-6 mg/sq cm compares with a present rate of 2-3 mg C/sq m. Unproductive Ennerdale Water (English Lake District) shows pollen evidence of major deforestation and cultivation around 1000 B.P. Blelham Tarn, a shallow, productive lake in the Lake District, shows increased sediment accumulation and eutrophication with deforestation also at about 1000 B.P. (Lynch-Wisconsin)
W79-08925

BIOLOGICAL AND CHEMICAL STUDIES OF SEDIMENTS FROM LLANGORSE LAKE, WALES,
Trent Univ., Peterborough (Ontario).
R. Jones, K. Benson-Evans, F. M. Chambers, B. A. Seddon, and Y. C. Tai.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 642-648, 6 fig, 17 ref.

Descriptors: *Llangorse Lake(Wales), *Palynology, *Sediments, *Eutrophication, *History, *Paleolimnology, *Agricultural runoff, Organic matter, Wales, Lakes, Chemical analysis, Phytoplankton, Diatoms, Chrysophyta, Algae, Anabaena flos-aquae, Cyanophyta, Stratigraphy, Cores, Radioactive dating, Carbon radioisotopes, Agriculture, Deforestation, Water pollution sources.

Palynology, diatom identification, and chemical analysis of sediments were used to study the history of shallow Llangorse Lake, the largest body of freshwater in southern Wales and subject to algal blooms over recent centuries. The study focused on a transition zone at 280-272 cm in a core from one basin (core 1) and at 244-240 cm in a core from the other basin (core 2), radiocarbon dated at 1790 + or - 60 yrs B.P. The stratigraphy showed a dramatic change from a lower black organic nekton mud to an upper inorganic red-brown silty clay. The date indicates the change occurred after the Roman defeat of the Silurians in A.D. 74-78. Following the campaign crop production was expanded around the lake, possibly to support local Roman garrisons. Sediments in the transition zone show declining tree pollen and increased grass, cereal, and weed pollen, accompanied by substantial soil erosion as indicated by the shift from organic to inorganic sediments. Apparently due to increased turbidity, epiphytic diatoms declined in transition zone sediments in core 1 as they were eliminated from macrophytes. Their continued absence above the zone suggests persistent turbidity. There was a pronounced increase in specific gravity and a corresponding decline in water content in the zone in core 1, and in both cores organic matter and Kjeldahl nitrogen decreased with increasing inorganic content. Iron, aluminum, magnesium, and potassium rose, but calcium did not until 150-100 cm. (Lynch-Wisconsin)
W79-08926

ECOSYSTEM EXPERIMENTATION IN THE MANAGEMENT OF A SYSTEM OF SHALLOW LAKES,
University of East Anglia, Norwich (England). School of Environmental Sciences.
B. Moss, R. T. Leah, and D. E. Forrest.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 649-653, 1 fig, 12 ref.

Descriptors: *Water management(Applied), *Macrophytes, *Eutrophication, *Gulls, *Water pollution sources, *Hickling Broad(England), Lakes, Norfolk Broads(England), England, Ecosystems, Shallow water, Phytoplankton, Algae, Diatoms, Chrysophyta, Cyanophyta, Nutrients, Phosphorus, Sewage disposal, Experimental ecosystems, Vollenweider models, Larus ridibundus, Najas marina, Potamogeton, Water pollution effects, Guano, Succession, Sediments, Peat.

Droppings from black-headed gulls (Larus ridibundus) are primarily responsible for eutrophication in shallow Hickling Broad (Norfolk Broads, England) and decline of the famed submerged macrophyte swards. Experiments with Lund Tubes (20-m diameter open enclosures embedded in sediments and extending to the surface) demonstrated that boat disturbances and mud texture are of secondary importance in the decline of the macrophytes. Gull guano did contaminate the tubes, however, focusing attention on eutrophication and nutrient sources. The birds are present October-January in flocks of 100,000-250,000, daily excreting about 38 mg P per bird. Their droppings contain both readily soluble and combined phosphorus and nitrogen. Some soluble nutrient is rapidly leached out but much falls to the sediments, the major nutrient source during the summer cyanophyte bloom. Immediately available phosphorus and ammonia plus nitrate and ammonium from the agricultural catchment support large populations of the diatoms Synedra sp. and Diatoma elongatum (over 190,000/ml, 200 microg chl-a/l), which decline in March due to deficiencies of soluble phosphorus, nitrogen, and silicon. Phytoplankton increase again in May, peaking in August with cyanophytes dominating. Nutrients are sufficient to maintain the bloom until concentrations are diluted by autumn flushing. Macrophytes in the lake had included the rare Najas marina, various charophytes, and Potamogeton spp. (Lynch-Wisconsin)
W79-08927

EVIDENCE FOR NUTRIENT RELEASE FROM THE SEDIMENTS OF TWO SHALLOW AND PRODUCTIVE LAKES,
University of East Anglia, Norwich (England). School of Environmental Sciences.
P. L. Osborne, and G. L. Phillips.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 654-658, 4 fig, 17 ref.

Descriptors: *Barton Broad(England), *Alderfen Broad(England), *Sediments, *Nutrients, *Water pollution sources, *Macrophytes, Phytoplankton, Algae, Norfolk Broads(England), Peat, Lakes, England, Phosphorus, Nitrogen, Silicon, Oxidation-reduction potential, Lake restoration, Bioavailability, Organic matter, Sewage disposal, Agricultural runoff, Shallow water, Nutrient loading.

Nutrient release from sediments in shallow, eutrophic Alderfen and Barton Broads (Norfolk, Broads, England), accounts for summer increases of phosphorus, ammonium-nitrogen, and soluble reactive silicon. Such release is indicated both by timing of nutrient increases and by presence of anaerobic conditions at the sediment surface around sunrise in summer, when water temperature is high and bacterial activity greatest. Such conditions would favor phosphorus release provided labile phosphorus-rich organic matter were present. Alderfen Broad receives its phosphorus supply from agricultural drainage, and Barton Broad receives 80% from sewage effluent carried by the River Ant. Algal growth in spring, dependent on external nutrient loading, probably has prevented recolonization of submerged macrophytes lost in the 1960s. Nutrient loading reduction should enable the plants to recolonize, and much of the summer release of nutrients from sediments could be taken up by the macrophytes, thus preventing summer algal growth. Phosphorus removal by phosphate-stripping of sewage effluent discharged to the Ant should effectively reduce phytoplankton in Barton Broad, though significant release of nutrients from sediments could continue for several years. At Alderfen Broad, which has no outflow of water in summer, phosphorus loading reduction would not lead to net export of phosphorus and recovery might not occur. The broads were formed in the late 13th century from flooded peat diggings. (Lynch-Wisconsin)
W79-08928

GROWTH AND PRODUCTION OF ISOETIDS IN OLIGOTROPHIC LAKE KALGAARD, DENMARK,
Copenhagen Univ., Hillerod (Denmark). Freshwater Biological Lab.
K. Sand-Jenson, and M. Sondergaard.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 659-666, 5 fig, 3 tab, 18 ref.

Descriptors: *Lake Kalgaard(Denmark), *Isoetids, *Littorella uniflora, *Lobelia dortmanna, *Leaves, *Plant growth, Macrophytes, Denmark, Lakes, Oligotrophy, Primary productivity, Leaf turnover rate, Biomass, Roots, Seasonal.

Leaf turnover rates of the isoetids Littorella uniflora and Lobelia dortmanna in oligotrophic Lake Kalgaard, Denmark, and unimodally seasonal with maxima in June (0.83%/day) and July (0.56%/day). Renewal of leaf biomass is 150%/yr for Littorella and 80% for Lobelia. Lobelia root turnover rate is equal to that of the leaves, probably true also for Littorella. Leaf growth was determined 1975-76 by marking the youngest leaf of 30-60 shoots with a nontoxic speed-marker (Penol 700) and checking growth after 1-2 months in summer and 5-7 months in winter. Turnover rate equals the number of leaves produced in proportion to total number present. Carbon-14 experiments with Littorella corresponded well to the leaf-marking tests. In July-August its photosynthesis is light-saturated most of the day, and short-term assimilation under ambient carbon dioxide concentrations is limited by carbon supply. About 95% of carbon-14 CO2 assimilated is taken up by roots, invalidating earlier isoetid production experiments in which carbon-14 CO2 were added only to leaves. Isoetids of rosette growth form dominate the macrophytes of Lake Kalgaard, occupying about 40% of the lake bottom. Net production on various sediment types is 124-383 g/sq m/yr (organic dry wt) for Littorella and 1.5-3.8 g for Lobelia, whose low production is due to low biomass. (Lynch-Wisconsin)
W79-08929

TOTAL AUTOTROPHIC PRODUCTION IN OLIGOTROPHIC LAKE KALGAARD, DENMARK,
Aarhus Univ. (Denmark). Botanical Inst.
M. Sondergaard, and K. Sand-Jenson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 667-673, 2 fig, 2 tab, 21 ref.

Descriptors: *Lake Kalgaard(Denmark), *Primary productivity, *Autotrophy, *Epiphytes, *Macrophytes, Phytoplankton, Chlorophyta, Denmark, Lakes, Algae, Bulbochaete, Mougeotia, Oedogonium, Spirogyra, Zygnema, Carbon radioisotopes, Littorella uniflora, Isoetes lacustris, Lobelia dortmanna, Oligotrophy.

Epiphyte, macrophyte, and total autotrophic production are presented for oligotrophic Lake Kalgaard, Denmark. Further data on physico-chemical conditions, phytoplankton production, and macrophyte distribution and production are published elsewhere. In Lake Kalgaard phytoplankton and submerged macrophyte production are equal, and production by littoral algal epiphytes is unimportant. The epiphytes cannot compete with either the phytoplankton, which obtain carbon dioxide and nutrients from the limnetic zone, or the macrophytes, which rely on sediments for carbon dioxide and nutrients. Low dissolved inorganic content of carbon, nitrogen, and especially phosphorus probably limits the quantitative importance of the epiphytes. Microbenthic algae are insignificant since the entire littoral is densely covered with the macrophytes Littorella uniflora, Isoetes lacustris, and Lobella dortmanna. Epiphytes are present only in the L. uniflora zone (0-2 m), dominated by species of the chlorophytes Bulbochaete, Mougeotia, Oedogonium, Spirogyra, and Zygnema. Epiphyte production, though greatly variable among parallel samples, is very low (less than 50 mg C/sq m lake bottom/day). Production is similar on sand and on an organic substrate due to higher leaf biomass. Seasonal variation is greater on the sand substrate. Total autotrophic production is lower than phytoplankton production of eutrophic lakes. (Lynch-Wisconsin)
W79-08930

QUANTITATIVE AND QUALITATIVE DETERMINATIONS OF CHLOROPHYLLS AND PHAEOPIGMENTS IN LAKE MOSSO,
Aarhus Univ. (Denmark). Botanical Inst.
B. Riemann.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 674-677, 2 fig, 23 ref.

Descriptors: *Lake Mosso(Denmark), *Eutrophication, *Chlorophyll, *Phaeopigments, *Chromatography, *Spectrophotometry, Methodology, Analytical techniques, Phytoplankton, Zooplankton, Algae, Pigments, Lakes, Denmark, Measurement, Phaeophorbide, Phaeophytin, Nutrients, Ecology, Biomass.

Quantitative spectrophotometric and chromatographic methods were used comparatively to determine relative chlorophyll-a and phaeopigment-a levels in Lake Mosso, Denmark, 1974-76 to evaluate ecological significance of naturally occurring phaeopigments in a eutrophic lake. Results show that estimates of phytoplankton biomass from chlorophyll must be corrected for the occurrence of phaeopigments. Phaeopigment-a in Lake Mosso is quantitatively close to that reported for the sea (23-86% chl-a) and from lakes (16-56%). Chlorophyll-a ranges from four mu-l in February 1975 to 1952 mu-l in August 1975. Phaeopigment-a is always present, varying from two mu-l in March 1976 to 56 mu-l in March 1974. Phaeopigment-a percentage relative to chlorophyll-a varies from 1.8% in March 1976 to 56.2% in April 1975. Chromatography recorded somewhat lower percentages than spectrophotometry (correlation r=0.98). Maximum occurrences of phaeopigment-a coincides with decreases in chlorophyll-a except on one occasion. Phaeophorbide-a is the main degradation product, whereas phaeophytin-a has only been recorded during a period of heavy zooplankton grazing. In June 1975 an enormous quantity of zooplankton (Cyclops, Daphnia) cleared the waters, then disappeared a week later. Only 38% chlorophyll-a was found chromatographically and phaeopigments consisted mainly of phaeophytin-a, which also disappeared after a week. Zooplankton are of minor importance in controlling phytoplankton during most of the year compared with nutrient depletion. (Lynch-Wisconsin)
W79-08931

RELATIONSHIP BETWEEN PHYTOPLANKTON PHOTOSYNTHESIS AND LIGHT, TEMPERATURE AND NUTRIENTS IN SHALLOW LAKES,
Odense Univ. (Denmark). Biological Inst.
E. Lastein, and E. Gargas.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 678-689, 8 fig, 5 tab, 38 ref.

Descriptors: *Lakes, *Phytoplankton, *Photosynthesis, *Primary productivity, *Light, *Water temperature, *Analytical techniques, Denmark, Shallow water, Chlorophyll, Nutrients, Model studies, Mathematical models, Equations, Respiration, Darkness, Seasonal.

For 18 shallow Danish lakes, results are reported of studies of effects of light, temperature and nutrients on three parameters: (1) light-saturated photosynthesis/unit chlorophyll-a (PBm); (2) photosynthesis/unit chlorophyll-a at low light levels, corresponding to dark respiration (PB); and the irradiance at which the initial and horizontal parts of the light-photosynthesis curve intersect (I sub K). Variations in the parameters correlated with irradiance, temperature, and nutrients in very complex ways; this indicates that predictions of daily phytoplankton production based only on measurements of the state variables chlorophyll-a and nutrients, and on the forcing functions light and temperature, give only a rough estimate of the real values. PB showed only slight variations during the collection period (February-November 1974), with average range of 0.9-1.4 mg C/mg chl-a. PBm showed strong variation, ranging from 2.7 to 5.2 mg C/mg chl-a/two hrs. I sub K varied seasonally from 4.0 to 8.2 cal/sq m/min. Highest PBm and I sub K values were found in the most eutrophic lakes and the lowest in the most oligotrophic, consistent with other studies. A possible explanation is that phytoplankton in oligotrophic waters are often smaller than in eutrophic waters, and the half-saturation constant for nutrient uptake in large cells is higher than for nonnoplankton. Contrary to results for grouped data, for all data PB correlated strongly with PBm, showing temperature has a greater influence on photosynthetic parameters than light. (Lynch-Wisconsin)
W79-08932

CYANOPHYCEAE AND ENVIRONMENTAL FACTORS IN 15 DANISH LAKES,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
K. Olrik.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 690-695, 2 fig, 4 tab, 5 ref.

Descriptors: *Denmark, *Cyanophyta, *Eutrophication, *Lakes, *Microcystis aeruginosa, *Nutrients, Phosphorus, Nitrogen, Depth, Algae, Phytoplankton, Organic matter, Luxury absorption, Ecology, Chemical properties, Magnesium, Zinc, Copper, Succession.

Blue-green algal maxima were studied in relation to mean concentrations of nutrients and microelements in 15 Danish lakes in order to clarify phytoplankton succession in increasingly eutrophic lakes. Positive correlations were found between cyanophycean and Microcystis aeruginosa maxima and mean values of total phosphorus (correlation coefficients of 0.65 and 0.66), total nitrogen (0.50, 0.67), inorganic nitrogen (0.63, 0.34), zinc (0.78, 0.81), copper (0.70, 0.78), and magnesium (0.63, 0.68). Cyanophycean maxima plotted against lake mean depth yielded a hyperbolic co-variation if lakes richest and poorest in phosphorus were excluded, indicating co-variation of cyanophycean maxima with mean depth and mean total phosphorus. The relationship of cyanophycean maxima to mean total nitrogen level was linear if lakes with lowest mean concentration of total phosphorus were excluded, indicating co-variation of cyanophycean maxima with mean total nitrogen and mean total phosphorus. Large cyanophycean maxima were found at mean depths of three m or less, and at mean total phosphorus concentrations above 0.25 mg/l. These conditions can be expressed as a rising hyperbola with decreasing depth and increasing mean total phosphorus level. A combination of high mean total phosphorus and nitrogen concentrations tended to be followed by a large cyanophycean maximum. The largest blue-green maxima were found in lakes with a combination of high mean total phosphorus and nitrogen levels, and a mean depth less than or equal to three m. (Lynch-Wisconsin)
W79-08933

NITROGEN AND PHOSPHORUS DYNAMICS IN EUTROPHIC FREDERIKSBORG SLOTSSO,
Copenhagen Univ. (Denmark). Freshwater Biological Lab.
O. S. Jacobsen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmarlk, 8 August 1977. Vol. 20, September 1978. Part 1, p 696-701, 3 fig, 21 ref.

Descriptors: *Frederiksborg Slotsso(Denmark), *Eutrophication, *Nitrogen, *Phosphorus, *Cycling nutrients, *Mineralization, Nutrients, Bacteria, Sediments, Zooplankton, Sedimentation rate,

Primary productivity, Lakes, Denmark, Summer, Degradation(Decomposition), Epilimnion, Hypolimnion, Phytoplankton, Algae.

Nitrogen and phosphorus regenerative velocity was investigated in Frederiksborg Slotsso, Denmark, and the influence of bacterial, zooplanktonic, and sedimentary mineralization was evaluated in this eutrophic lake. Results confirm that rapid recycling occurs during summer in eutrophic as well as in oligotrophic lakes, but in Frederiksborg Slotsso bacterial decomposition (60-80% of total regeneration) was more important than zooplanktonic regeneration (3-7%), contrary to the situation in oligotrophic lakes. In addition, phosphate and inorganic nitrogen recycling times were of the same order of magnitude during the entire growing season, (April-September). During the growing season 85% of total mineralization occurred in the eplimnion and 15% in the hypolimnion and sediment. Zooplankton mineralization was almost negligible compared to net phytoplankton uptake. Frederiksborg Slotsso is located in North Zealand, and has an area of 20.9 ha and a mean depth of 3.1 m. Annual gross primary production is 560 g C/sq m (phytoplankton only). Physical and chemical data were gathered semimonthly September 1975-November 1976. Increased inorganic phosphorus and nitrogen levels promoted production of algal phosphorus and nitrogen, followed by decomposition of algae by zooplankton and bacteria and an increased sedimentation rate, leading to increased nutrient release from sediments. (Lynch-Wisconsin)
W79-08934

PLANKTON PRIMARY PRODUCTION AND RESPIRATION IN EUTROPHIC FREDERIKSBORG SLOTSSO, DENMARK,
Copenhagen Univ., Hillerod (Denmark). Freshwater Biological Lab.
J. M. Andersen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 702-708, 5 fig, 2 tab, 11 ref.

Descriptors: *Frederiksborg Slotsso(Denmark), *Primary productivity, *Respiration, *Phytoplankton, *Bacteria, *Eutrophication, Zooplankton, Algae, Denmark, Lakes, Food chains, Ecosystems, Ecology, Organic matter, Gross primary production, Net primary productions, Carbon radioisotopes, Chlorophyll, Light-dark bottle method, Testing procedures, Methodology.

Measurement of both gross primary production (GPP) of autotrophs and net primary production (NPP) (which considers production and organic matter cycling) is necessary for describing food chain relationships in aquatic ecosystems. NPP, essential for determining the amount of organic matter potentially available to consumers, is very difficult to measure since it is usually impossible to determine bacterial respiration separately. In consequence NPP estimates within 50% of real values are probably nonexistent. In this study phytoplankton NPP minus bacterial respiration was measured with the oxygen light and dark bottle technique with corrections for zooplankton respiration, using data from Frederiksborg Slotsso, a small eutrophic lake in Zealand, Denmark, with an area of 21 ha and a mean depth of three m. The ecological significance of the NPP thus measured is that it roughly corresponds to the amount of organic matter available to links in the food chain following algae and bacteria. Algal NPP is about half that of GPP in the lake, probably not an uncommon situation. NPP may constitute a variable fraction of GPP, and the practice of calculating NPP as 7-80% of GPP is therefore inaccurate and misleading. Zooplankton respiration amounts to about 13% of GPP, though accuracy may be low since the value was calculated indirectly from zooplankton weight. Some data suggest that algae are the main contributors to algal and bacterial respiration, with bacteria playing a minor role. (Lynch-Wisconsin)
W79-08935

TOXICITY OF A PHOSPHATE-REDUCING AGENT (ALUMINUM SULPHATE) ON THE ZOOPLANKTON IN THE LAKE LYNGBY SO,
Copenhagen Univ. (Denmark). Inst. of Comparative Anatomy.
T. Sonnichsen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 709-713. 4 fig, 11 ref.

Descriptors: *Lyngby So(Denmark), *Toxicity, *Aluminum sulfate, *Phosphates, *Lake restoration, *Zooplankton, *Eutrophication, *Alum, Denmark, Lakes, Aluminum, Sediments, Nutrients, Flocculation, Cladocera, Copepods, Cyclops strenuus, Chydorus sphaericus, Bosmina longirostris, Ecology, Suspended solids, Lethal limit, Metabolism, Flushing rate, Hydrogen ion concentration, Environmental effects, Phytoplankton, Algae, Ecosystems.

Application of aluminum sulfate to limit sediment phosphate release in Lyngby So, a eutrophic Danish lake of one million cu m, drastically reduced zooplankton density to about 20 ind/l shortly after application. Cladocerans dropped from 45% of zooplankton to 20% 15 days after treatment. Beginning May 1974, 126 tons of aluminum sulfate were added over a two-month period. Treatment had only a transitory effect on phosphate-phosphorus concentration. Though zooplankton subsequently increased to even higher values than prior to treatment, the reducing agent definitely was lethal to zooplankton, and continued addition of the agent might have reduced them even further, resulting in a phytoplankton bloom. The relatively low damage to the zooplankton probably was due to rapid water exchange in the lake (water is renewed nine times/yr) and because the normal pH of nine is unfavorable to the desired flocculation of aluminum phosphate complexes (the optimum pH is 4-7). Although this type of restoration is most suitable for lakes with slow water renewal rates, direct application of aluminum salts to freshwater systems should be avoided because: (1) the metal contamination has serious effects on fauna, and (2) most lakes in need of restoration have high pH. Dominant zooplankters in Lyngby So were Bosmina longirostris, Chydorus sphaericus, and Cyclops strenuus. (Lynch-Wisconsin)
W79-08936

INFLUENCE OF BATHYMETRY ON SEDIMENT FOCUSING IN LAKE ESROM,
Copenhagen Univ. (Denmark). Freshwater Biological Lab.
L. Kamp-Nielsen, and B. T. Hargrave.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 1, p 714-719. 1 fig, 2 tab, 15 ref.

Descriptors: *Lake Esrom(Denmark), *Bathymetry, *Sediment focusing, *Organic matter, *Nutrients, *Sediment transport, Denmark, Lakes, Sediments, Sedimentation, Phosphorus, Carbon, Nitrogen, Depth, Cores, Mixing.

Increasing concentrations of sediment organic matter, total phosphorus, organic carbon, and nitrogen with depth in evenly spaced sediment cores taken 28-30 October 1974 from the central area of Lake Esrom, Denmark, indicate the occurrence of sediment focusing (enhanced sediment accumulation in the deeper parts of a basin). Areas of organic matter accumulation correspond to depressions in the lake's profundal zone. Accumulation of organic carbon, nitrogen, and phosphorus at the base of steep slopes at depths of 13-16 m could be caused by sediment slumping, turbidity flows, or gradual erosion through current-induced water movement. Increased sedimentation has been observed during autumn overturn when mixing resuspends bottom sediments. This process undoubtedly transports much fine-grained sediment to the center of the lake, which, besides enhancing accumulation in deepest areas, also concentrates materials in specific areas. Spatial differences between patterns of concentrations for phosphorus, carbon, and nitrogen both horizontally and vertically in the sediment probably reflect degradation and exchange processes which remineralize phosphorus to a greater degree or more rapidly than carbon and nitrogen. Linear regression showed depth alone accounted for only a small fraction of the variance in measures of sediment organic and phosphorus content. Measures of organic matter, carbon, and nitrogen were significantly correlated, but not with total phosphorus. C:N ratios correlated poorly with other measures. (Lynch-Wisconsin)
W79-08937

MODELLING THE VERTICAL GRADIENTS IN SEDIMENTARY PHOSPHORUS FRACTIONS,
Copenhagen Univ. (Denmark). Freshwater Biological Lab.
L. Kamp-Nielsen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 720-727. 5 fig, 2 tab, 13 ref.

Descriptors: *Mathematical models, *Lake Esrom(Denmark), *Sediments, *Phosphorus, *Nutrient flux, *Mineralization, Equations, Model studies, Denmark, Lakes, Vertical distribution, Nutrients, Metabolism, Sedimentation, Oxygen, Phosphates, Diffusion, Sediment-water interfaces, Nutrient loading.

A dynamic multilayer sediment model incorporating most known processes to affect phosphorus migration in lake sediments is based on data for dimictic, mesotrophic Lake Esrom, Denmark. The model describes sediment-water exchange of nutrients when a change in loading occurs, and provides information about processes governing the exchange. The model consists of 60 layers in the active part of the sediments, 50 one-mm layers in the top five cm, and 10 five-mm layers in the 5-10 cm interval. In each layer mineralization of particulate organic phosphorus, sorption equilibrium between dissolved and absorbed phosphate, and diffusion along concentration gradients takes place. Systematic deviations between predicted and observed values makes the current model unsuitable for total lake modelling, but it can provide information for further sediment modelling. Deviations may be due to incorrect process descriptions or use of excessively stiff equations. Results indicate a substantial source of error was a too-rapid shift between layers due to use of too high a rate constant for early spring decomposition. Resulting low exchangeable phosphorus values persist throughout the sediment column because no positive contribution to this pool is described by the model. A mineralization constant changing with time or quality of sedimented material could correct this problem. Partition between various pools of sedimentary phosphorus based on chemical analysis may not accurately identify specific pools and processes. (Lynch-Wisconsin)
W79-08938

SEASONAL AND INTERSPECIFIC VARIATION IN CONSUMPTION OF EPHEMEROPTERA BY BROWN TROUT IN A SUBALPINE LAKE,
Oslo Univ. (Norway). Zoological Museum.
J. E. Brittain, and L. Lien.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 728-733. 2 fig, 2 tab, 12 ref.

Descriptors: *Brown trout, *Ephemeroptera, *Feeding rates, *Ovre Heimdalsvatn(Norway), *Food habits, *Seasonal, Salmo trutta, Lakes, Norway, Insects, Benthic fauna, Fish, Subalpine, Mountain lakes, Leptophlebia vespertina, Leptophlebia marginata, Faunal lists, Crustaceans.

Ephemeroptera, mostly mature numphs, constitute 3.7% (range 1.6-7.7%) of total annual caloric intake of brown trout, Salmo trutta, from Ovre Heimdalsvatn, a Norwegian lake, based on stomach contents examined 1969-72. Ephemeroptera,

found in 24.6% of 1588 trout specimens, are most abundant and constituted a higher proportion of caloric intake in June and July. Adults were rarely taken. Leptophlebia vespertina account for 68.3% of the Ephemeroptera consumed annually, and L. marginata 17.8%; other species are Baetis rhodani (4.4%), Siphlonurus lacustris (3.1%), and B. macani (1.3%). The relative importance of Ephemeroptera varies seasonally due principally to their life cycle and relative sizes. The lotic species B. rhodani and B. lapponicus are consumed mainly in spring. Such an apparently attractive species as S. lacustris having large size and relatively high density is underrepresented in trout stomachs. S. lacustris and S. aestivalis are eaten almost exclusively June-August, since at other times they are either in the egg stage or nymphs were too small. Maximum consumption of all species occurs immediately before or during their emergence period, when nymphs are largest, mostly day-active, and are migrating towards shore to emerge. The trout are usually captured with gill nets. Trout over 500 g consume somewhat fewer Ephemeroptera than did smaller fish, feeding to a greater extent on the crustaceans Gammarus lacustris and Lepidurus arcticus. (Lynch-Wisconsin)
W79-08939

EUTROPHICATION OF LAKE MJOSA IN RELATION TO THE POLLUTIONAL LOAD,
Norsk Inst. for Vannforskning, Blindern.
H. Holtan.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 734-742. 7 fig, 2 tab, 14 ref.

Descriptors: *Lake Mjosa(Norway), *Eutrophication, *Water pollution sources, *Water pollution effects, *Nutrient loading, *Limiting factors, Potable water, Municipal wastes, Norway, Lakes, Oscillatoria bornetti f tenuis, Cyanophyta, Odor-producing algae, Taste-producing algae, Succession, Nitrogen, Phosphorus, Nutrients, Hydraulic residence time, Fragilaria crotonensis, Diatoms, Urbanization, Fertilizers, Sediments, Seiches, Phytoplankton, Algae, Silicon, Light, Water temperature, Water supply.

Reduction of phosphorus loading to severely eutrophic Lake Mjosa, Norway's largest lake, seems the only practical means of preventing mass development of taste and odor-causing blue-green algae and reducing total algal production. Eutrophication is also dependent on several uncontrollable factors, including light, temperature and silicon content. Planned control measures include regulations limiting phosphorus inputs from agricultural fertilizers and industry, construction of phosphorus removal sewage treatment plants, and encouraging use of phosphate-free detergents. Lake Mjosa has a maximum depth of 449 m, mean depth of 153 m, surface area of 365 sq km, and theoretical retention time of six years. Signs of eutrophication first appeared in the early 1950s, and by the early 1960s algal biomass was increasing and phytoplankton composition changing. The nutrient-demanding diatom Fragilaria crotoensis appeared in great numbers. In recent years commonly occurring algal blooms were increasingly dominated by cyanophytes, especially Anabaena flos-aquae and Oscillatoria bornetii f. Tenuis. The latter was dominant 1975-76, constituting about 95% of algal biomass in fall 1976. Maximum algal production was about 2000 mg C/sq m/day. Annual production is relatively low (100 g C/sq m) due to the short production period (June-September). Basin population has grown from 116,000 in 1900 to 200,000 in 1975. Phosphorus loading is about one g/sq m lake surface/yr, and N about 15 g/sq m/yr. Odor and taste in drinking water are intensified with chlorination. (Lynch-Wisconsin)
W79-08940

BUFFERING OF ACID LAKES BY SEDIMENTS,
Oslo Univ. (Norway).
D. Hongve.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 1, p 743-748. 1 fig, 3 tab, 12 ref.

Descriptors: *Acidic water, *Neutralization, *Sediments, *Acid precipitation, *Svenskestutjern(Norway), *Vilbergtjern(Norway), Lakes, Norway, Air pollution effects, Water pollution sources, Hydrogen ion concentration, Cores, Chemical analysis, Ions, Sulfuric acid, Sulfates, Sulfur, Calcium, Absorption, Seepage, Flushing rate, Degradation(Decomposition), Ammonia, Ammonium, Buffers.

Sediments in Svenskestutjern and Vilbergtjern, two extremely dilute Norwegian seepage lakes with very low water renewal rates, are important buffers of acidity due to acid precipitation. Average pH is about 5.3-5.6, significantly less acid than precipitation. The neutralizing processes identified through laboratory tests with sediment cores are probably more important is this type of lake than in ordinary drainage lakes with short renewal times, where acidification problems are most severe. Sediment cores were exposed to extreme acidification in the laboratory; however, natural acidification is due in great part to sulfuric acid. Liberation of absorbed bases is probably less important in nature than in the tests. Calcium is the ion with the greatest absorbed concentration in the sediments. Sulfate reduction is important as indicated by a lower final sulfate concentration, and the fact that sulfate in the lake is lower than in precipitation. Since sulfate reduction is strictly an anaerobic process, it generally occurs only in sediments. Reduction of sulfate leads to a corresponding decrease in strong acid concentration. Under aerobic conditions sulfate absorption to the sediment surface is possible, likewise reducing acidity. Production of ammonia during organic matter decomposition also results in acid neutralization through formation of ammonium ions. Subsequent nitrification of the ammonium would have the opposite effect. (Lynch-Wisconsin)
W79-08941

RECENT SEDIMENTS IN A EUTROPHICATED LAKE: ARUNGEN, NORWAY,
Oslo Univ. (Norway). Dept. of Limnology.
O. K. Skogheim.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 749-757.

Descriptors: *Lake Arungen(Norway), *Sediments, *Eutrophication, *Nutrients, *Organic matter, *Spatial distribution, Lakes, Norway, Cores, Nutrient loading, Vertical distribution, Horizontal distribution, Depth, Lake restoration, Phosphorus, Carbon, Nitrogen, Ignition loss, Hydrogen ion concentration, Oxidation-reduction potential.

Accumulation and horizontal distribution of organic matter, nutrients, and other substances in sediments of eutrophic Lake Arungen, south of Oslo, Norway, were studied with 25-cm sediment cores taken in February 1977 at several locations and depths. Projected reduction in external loading to the lake may make sediments a significant source of internal loading. Allochthonous clay is the most important inorganic component of the sediments, while the organic component is mainly autochthonous clay originating mostly from plankton. Ignition loss (IL) and total carbon (TC) showed a highly significant statistical relationship (correlation coefficient 0.960). Highly significant correlation coefficients for total nitrogen (TN) vs IL (0.947) and TC (0.983) indicate sediment nitrogen is primarily in an organic form. Correlation coefficients for total phosphorus (TP) vs IL (0.782), TC (0.803), and TN (0.786) are significant at the 0.001 probability level. Correlation coefficients for water content vs organic matter are highly significant, reflecting water binding capacity of the organic matter. Both pH and Eh vary seasonally but do not correlate significantly with organic matter or phosphorus. Eh, pH, TC, TN, and TP are regularly distributed horizontally in surficical sediments, closely related to lake basin morphometry. All parameters show vertical variations within each core, dependent on lake depth. Organic matter and TP decrease sharply in profundal sediment cores from the surface to about 10 cm, below which the decrease is slower. (Lynch-Wisconsin)
W79-08942

CRYOCHEMISTRY OF LAKES WITH SPECIAL REFERENCE TO FORMATION, DISTRIBUTION, AND EFFECT OF PHOSPHORUS AND HYDRONIUM. A PRELIMINARY REPORT,
Norges Landbrukshoegskole, Vollebekk. Dept. of Agricultural Hydrotechnics.
O. Groterud.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 758-764, 1 fig, 5 tab, 13 ref.

Descriptors: *Hydronium, *Phosphorus, *Lakes, *Norway, *Ice-water interfaces, *Freezing, Acids, Acidic water, Ice cover, Snow, Phosphates, Cores, Ice, Reviews, Water pollution sources.

The cryochemistry of four meromictic and four holomictic lakes with low flow-through rates near Oslo, Norway was studied, emphasizing phosphorus, hydronium, and lake acidification. Ice cores, snow samples, and water samples were collected, and freezing and phosphate absorption experiments conducted. In the freezing experiments, different water samples of known composition were placed in 50-liter plastic containers and partially submerged in an ice-covered pond. Phosphate absorption tests were carried out by submerging ice sheets of distilled water in a 10-liter plastic container with a specific phosphate solution. In freezing tests, the ice thus formed was clear, with electrolytes and soluble organic matter completely frozen out, and phosphorus partially frozen out. Cryochemistry is of special importance for lakes with low-flow-through rates and with great volume of ice and snow relative to water, as in shallow lakes with small watersheds. The meromictic lakes studied circulate down to only a few meters in the spring thaw, and the icemelt is therefore an important determinant of phosphorus concentration in trophogenic layers. The four holomictic lakes were important for studying acidic ice and lake acidification. A review is given of the few previous papers on lake cryochemistry. Data are presented in five tables. (Lynch-Wisconsin)
W79-08943

ACID PRECIPITATION: CHEMISTRY AND FISH POPULATIONS IN 700 LAKES IN SOUTHERNMOST NORWAY,
Norsk Inst. for Vannforskning, Blindern.
R. F. Wright, and E. Snekvik.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 765-775. 4 fig, 2 tab, 17 ref.

Descriptors: *Sorlandet(Norway), *Acid precipitation, *Lakes, *Water chemistry, *Water pollution effects, *Fish, Acidic water, Water pollution sources, Brown trout, Salmo trutta, Norway, Environmental effects, Fish reproduction, Conductivity, Hydrogen ion concentration, Ions, Salts, Calcium, Sodium, Chlorine, Magnesium, Coasts, Chemical analysis.

Water chemistry and fish data for 700 small lakes (0.1-1.0 sq km) in the Sorlandet area of southern Norway were analyzed in 1974-75. Comparison with data on acid precipitation showed that precipitation chemistry dominates lake water chemistry in the area, and acid stress has resulted in elimination of fish populations from about 40% of the lakes. Another 40% of the lakes have sparse populations of the fish, mainly brown trout (salmo trutta). The lakes displayed distinct and regular geographic patterns of water chemistry: (1) pH levels followed a gradient ranging from 4.4-4.6 near the coast to 5.0-5.2 100 km inland; (2) sulfate concentrations followed a similar gradient; and (3) chlorine and sodium gradients were markedly

steeper. These patterns reflected precipitation chemistry gradients; concentrations of sea-salt components such as chlorine, sodium, and magnesium, were highest near the coast, declining rapidly inland, while concentration gradients for long-range transported components such as H(+) and sulfate were less steep. Fish reproduction is most affected by acid stress, with loss of fish populations due primarily to recruitment failure, though adult fishkills have also occurred. Multiple regression analysis indicates pH and calcium are the most important factors affecting the fish; calcium apparently ameliorates acid stress, probably by reducing sodium loss. Acid stress to fish appears more acute in waters of very low ionic strength. (Lynch-Wisconsin)
W79-08944

SOME OBSERVATIONS ON RED-COLOURED SPECIES OF OSCILLATORIA (CYANOPHYCEAE) IN NUTRIENT-ENRICHED LAKES OF SOUTHERN NORWAY,
Norsk Inst. for Vannforskning, Blindern.
O. M. Skulberg.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 776-787. 7 fig, 3 tab, 27 ref.

Descriptors: *Norway, *Lakes, *Cyanophyta, *Oscillatoria, *Eutrophication, *Water pollution effects, Agricultural runoff, Domestic wastes, Sewage disposal, Succession, Algae, Phytoplankton, Lake Steinsfjorden(Norway), Lake Mjosa(Norway), Lake Gjersjoen(Norway), Pigments, Phycobilins, Photosynthesis, Oscillatoria rubescens, Oscillatoria bornetii, Oscillatoria agardhii, Classification, Identification, Trophic level, Aphanizomenon flos-aquae, Anabaena flos-aquae, Red trichomes.

Observations on cyanophytes in eutrophic lakes of southern Norway are summarized, and the invasion of species of Oscillatoria in lakes and slow rivers is described, with an account of three red-colored Oscillatoria species. Planktonic investigations have been carried out since 1957, with intensive studies of some inland waters enriched by agricultural runoff and sewage, including Lakes Mjosa, Steinsfjorden, and Gjersjoen, the River Glama, and the Halden watercourse. About 16 of 54 cyanophyte species are common, some capable of forming dense blooms, especially Anabaena flow-aquae, Aphanizomenon flos-aquae, and Oscillatoria spp. Formation of Oscillatoria blooms is closely associated with lake progression from oligotrophy to eutrophication. Only a few of the 15 Oscillatoria species reported form blooms: Q. agardhii, O. agardhii var. isothrix, O. agardhii var., O. bornetii f. tenuis, and O. rubescens. Among successful invading bloom-forming Oscillatoria species, three with red-colored trichomes are remarkable; their occurrence in three lakes is discussed: (1) O. agardhii var., Lake Gjersjoen; (2) O. rubescens, Lake Steinsfjorden; and (3) O. bornetii f. tenuis, Lake Mjosa. O. agardhii has an efficient pigment synthesis regulatory mechanism which maintains optimum pigment content under varying environmental conditions, and the presence of phycobilins as accessory photosynthetic pigments may provide an ecological advantage under low-light conditions. (Lynch-Wisconsin)
W79-08945

RELATIONSHIP BETWEEN HETEROTROPHIC BACTERIA AND PHYTOPLANKTON IN EUTROPHIC LAKE WITH WATER BLOOMS DOMINATED BY OSCILLATORIA AGARDHII,
Norsk Inst. for Vannforskning, Blindern.
K. Ormerod.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 788-793. 4 fig, 3 tab, 8 ref.

Descriptors: *Oscillatoria agardhii, *Eutrophication, *Nutrient regeneration, *Organic matter, *Bacteria, *Lake Gjersjoen(Norway), Heterotrophy, Phytoplankton, Algae, Lakes, Water pollution effects, Red trichomes, Cytophaga, Cyanophyta, Particulates, Depth, Epilimnion, Stratification, Nutrients, Cycling nutrients, Norway.

Study of heterotrophic bacteria in eutrophic Lake Gjersjoen, Norway in 1972-73 to determine their role in plant nutrient regeneration showed that total heterotrophic plate count is not a good measure of bacteria actively involved in nutrient regeneration, and that separate counting of different colonies gives better results. Despite low epilimnetic nutrient levels during autumn blooms, photosynthetic activity by phytoplankton did not decrease. Strong summer stratification indicated hypolimnetic regeneration of plant nutrients could not affect phytoplankton nutrient supply, and so was not considered. The red-colored variant of Oscillatoria agardhii dominated phytoplankton during particulate organic matter (POM) density peaks in June-July and October. As it was assumed that phytoplankton would use plant nutrients as quickly as they were regenerated, no increases in nutrient concentrations were expected or found during periods of high bacterial densities. On the other hand, high densities of heterotrophic bacteria were expected in periods of low nutrient concentrations and high POM densities, not the case when total colony count was used to calculate bacterial density. A correlation was found, however, when fluctuations in yellow colony bacteria were compared with POM. Dominance by these bacteria, many of which resembled Cytophaga, coincided with the red O. agardhii variant, but whether these bacteria actively degraded the phytoplankton or simply used organic matter excreted by them remains unknown. (Lynch-Wisconsin)
W79-08946

EFFECTS OF FISH REMOVAL FROM A SMALL LAKE,
Goteborg Univ. (Sweden). Dept. of Zoology.
J. A. E. Stenson, T. Bohlin, L. Henrikson, B. I. Nilsson, and H. G. Nymann.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 794-801. 10 fig, 14 ref.

Descriptors: *Lake Lilla Stockelidsvatten(Sweden), *Fish removal, *Food webs, *Ecology, *Predation, *Grazing, *Trophic level, *Oligotrophy, Biological communities, Fish, Lake Stora Stockelidsvatten(Sweden), Lakes, Bohuslan(Sweden), Size, Food habits, Roach, Perch, Leuciscus rutilus, Perca fluviatilis, Mathematical models, Model studies, Pyrrophyta, Succession, Eutrophication, Primary productivity, Algae, Phytoplankton, Ecosystems, Competition, Sweden, Cladocera, Copepods.

Experimental elimination with rotenone of all fish from one of two small adjacent lakes in Bohuslan, Sweden in November 1973 dramatically shift toward oligotrophy due to profound changes in the food web, especially in regard to body size and selective feeding. Removal of fish (dominated by roach, Leuciscus rutilus) from Lake Lilla Stockelidsvatten resulted in: (1) 90% reduction of limnetic primary production by 1975 (from about 17 mg C/cu m/hr in surface waters to less than 3 mg); (2) increase in net phytoplankton biomass with dominance by pyrrophytes (e.g., Ceratium hirundinella); (3) change in zooplankton dominance from small cladocerans (e.g., Bosmina longirostris) to large copepods (e.g., Eudiaptomus gracilis); (4) transparency increase probably due to a decrease in nannoplankton; (5) lower pH probably due to lower primary production; (6) decrease in total phosphorus concentration; and (7) increase in invertebrate plankton predators, such as Chaoborus sp. and Glaenocorisa propinqua. No similar changes occurred in Lake Stora Stockelidsvatten, whose fish population was dominated by roach and perch (Perca fluviatilis). A remineralization theory was developed to explain phytoplankton community changes by means of a nutrient recycling model: a shift from small grazers with large turnovers (cladocerans) to larger forms with low turnovers (calanoid copepods) caused increased grazer density, reduced phytoplankton density and production, and increased available nutrients, favoring algae which are weak competitors for nutrients and insensitive to grazing (pyrrophytes). (Lynch-Wisconsin)
W79-08947

INFLUENCE OF ACIDIFICATION ON DECOMPOSITION PROCESS IN LAKE SEDIMENT,
Lund Univ. (Sweden). Limnological Inst.
G. Andersson, S. Fleischer, and W. Graneli.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. part 2, p 802-807, 2 fig, 8 tab, 11 ref.

Descriptors: *Sweden, *Lakes, *Acid precipitation, *Acidic water, *Sediments, *Degradation(Decomposition), Oligotrophy, Hydrogen ion concentration, Lake Fiolen(Sweden), Lake Skarsjon(Sweden), Lake Tjarnesjon(Sweden), Lake Stora Neden(Sweden), Iron, Manganese, Silica, Zinc, Water chemistry, Respiration, Water pollution effects, Trophic level, Glucose, Phosphates, Nutrients, Sediment-water interfaces, Detritus.

Evaluation of effects of acidification on sediment processes through study of four Swedish lakes (two of which were acidified) showed that the bulk of sediment material was unaffected by the acid water. Because of the strong buffering capacity of the sediment, deeper sediment layers were not acidified, and only decomposition of material lying on the sediment surface, such as coarse detritus, is retarded by low pH. Low pH conditions (5.0-5.1 in summer) in Lakes Tjarnesjon and Stora Neden are probably due to acid precipitation. Summer pH in the control lakes, Fiolen and Skarsjon, was 6.8. In experiments on glucose turnover time, a series involving acclimatization for 26 days showed highest turnover time at pH 6.0 and shortest at 8.0, while a series with 98-day acclimatization showed longest turnover time and lowest glucose concentrations at pH extremes of 4.0 and 8.5, and shorter turnover times and high substrate concentrations at 6.0 and 7.0. The pH decrease did not lower sediment respiration below typical oligotrophic values. Acidification of water overlying Lake Tjarnesjon sediment resulted in low phosphate concentration in the water, whereas raising pH increased phosphate levels. With decreasing pH, release of iron from sediments decreased resulting in a decrease in water color, while release of manganese and zinc increased; reactive silica was not affected. (Lynch-Wisconsin)
W79-08948

EPILITHIC ALGAL PRESENCE AND PIGMENT COMPOSITION ON NATURALLY OCCURRING AND ARTIFICIAL SUBSTRATES IN LAKES TRUMMEN AND FIOLEN, SWEDEN,
Queen's Univ., Kingston (Ontario). Dept. of Biology.
A. S. Rosemarin, and C. Gelin.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 808-813. 3 fig, 7 ref.

Descriptors: *Periphyton, *Epilithic, *Pigments, *Lake Trummen(Sweden), *Lake Fiolen(Sweden), *Artificial substrates, *Bioindicators, Testing procedures, Research equipment, Algae, Sessile algae, Lakes, Sweden, Eutrophication, Oligotrophy, Trophic level, Substrates, Rocks, Benthic flora, Chlorophyll, Pheopigments, Glass slides, Plastics, Granites, Succession.

Glass, plexiglas, and red granite were compared with natural rock substrates to test their suitability for experiments with epilithic flora. Tests were conducted in oligotrophic Lake Fiolen and eutrophic Lake Trummen, Sweden. The artificial substrates were cut to microscope slide size, placed vertically (one each) in uncovered plastic slide boxes with the bottom removed, and, secured to a brick, set out at 0.5-m depths on the littoral bottom in October 1975, and in February, April, May, and

June 1976. One unit was removed from each installation 19 June and 21 July 1976, along with naturally occurring rocks. In Lake Fiolen chlorophyll-a and pheopigment-a concentrations were consistently higher on the natural substrates than on the artificial ones; chlorophyll densities were relatively uniform regarding age of substrate. In Lake Trumman pigment density varied greatly by age of substrate. For the 19 June sample, density increased gradually except for the four-month substrate, which had pigment densities almost twice those of natural ones, probably caused by a very small coccoid cyanobacterium peculiar to these substrates. Pigment densities for the 21 July sample were relatively uniform for all substrates. Algal degradation as expressed by pheopigment concentrations may be a good means of comparing natural and artificial substrates. Granite and plexiglas appear preferrable to glass for testing. Pigment densities were very similar for the two lakes, indicating periphyton standing crop is not a good indicator of trophic status. (Lynch-Wisconsin)
W79-08949

SITUATION OF TWENTY-FIVE SWEDISH LAKES NOW AND 40 YEARS AGO,
Uppsala Univ. (Sweden). Inst. of Limnology.
M. Wallsten.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 814-817, 3 fig, 6 ref.

Descriptors: *Lakes, *Sweden, *Conductivity, *Sulfates, *Phosphorus, *Water pollution effects, *Agricultural runoff, Nutrients, Macrophytes, Municipal wastes, Industrial wastes, Sewage disposal, Water levels.

Reinvestigation in 1975 of 25 Swedish lakes included among 167 studied by Lohammar in 1934 showed remarkable increases in conductivity, sulfate, and total phosphorus in many of the lakes, attributed to the influence of human activity. In 1934 conductivity ranged 20-600 microS/cm, compared with 30-1000 microS/cm in 1975. Sulfate concentrations nearly doubled in all lakes by 1975, and in several the increase was even more dramatic. In 1934 sulfate ranged about 0-48 mg/l, while in 1975 it ranged abqut 11-328 mg/l. In 11 of the 25 lakes total phosphorus showed little or no increase, while the rest showed moderate to very large increases. Since most of the lakes are located in agricultural areas, a higher increase was expected. Lakes which have received industrial and municipal sewage have exhibited notable increases. Total phosphorus in 1934 varied about 2-117 microg/l, and in 1975 about 8-372 microg/l. Though there are no macrophyte distribution maps from the 1930s, comparison of photographs from the two surveys showed no changes in the large lakes, such as Erken and Lilla Ullevifjarden, nor in some smaller woodland lakes. Some shallow lakes which had abundant aquatic vegetation in the 1930s, both emergent and floating, are now dominated by emergent species. Two of the 25 lakes have been filled in by vegetation since 1934, partially because of a lower water level. The greatest vegetative change in most lakes was in the supralittoral zone, now overgrown with shrubs. (Lynch-Wisconsin)
W79-08950

LONG-TERM CHANGES IN THE PROFUNDAL BENTHOS OF LAKE MALAREN,
National Swedish Environment Protection Board, Uppsala. Limnological Survey.
T. Wiederholm.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. part 2, p 818-824, 5 fig, 2 tab, 11 ref.

Descriptors: *Lake Malaren(Sweden), *Eutrophication, *Benthic fauna, *Phytoplankton, *Lake restoration, *Predation, *Water pollution control, Water level fluctuations, Lakes, Sweden, Municipal wastes, Sewage disposal, Organic matter, Nutrients, Algae, Biomass, Lake morphometry, Profundal zone, Species composition, Species diversity, Chironomidae, Fish, Competition, Chlorophyll, Primary productivity, Oligochaetes, Pontoporeia affinis, Crustaceans, Ruffe, Burbot.

Investigation of the composition and abundance of profundal benthic fauna in Lake Malaren, Sweden 1969-76 showed: (1) maxima of oligochaete abundance corresponded to peaks in chlorophyll concentration with a lag phase of 2-5 years; (2) drastic decline of the crustacean Pontoporeia affinis over the study period appears due increased fish-predation from ruffe (positively affected by eutrophication and decreased predation from burbot); and (3) increased chironomid abundance following the disappearance of Pontoporeia was probably the result of lower interspecific competition for food and space. Since 1970 strong measures have been taken to decrease or eliminate inputs of nutrients and organic matter from municipal sewage effluent to the lake, which had been showing signs of rapidly progressing eutrophication. Control efforts coincided with a period of reduced water flow through the lake caused by unusually low winter precipitation. Reduced loading has produced significantly improved water quality in terms of transparency and phytoplankton biomass. At a depth of 30 m oligochaetes dominated numerically at the beginning of the study period, with chironomids and Pontoporeia second. By the middle of the period Pontoporeia had almost disappeared and oligochaetes made up 80%, but by the end of the period chironomids were dominant. At 50 m crustaceans dominated at the beginning, then disappeared and oligochaets and chironomids became dominant. (Lynch-Wisconsin)
W79-08951

RESEARCH ON RECOVERY OF POLLUTED LAKES. I. IMPROVED WATER QUALITY IN LAKE BOREN AND LAKE EKOLN AFTER NUTRIENT REDUCTION,
Uppsala Univ. (Sweden). Inst. for Physiologic Botany.
C. Forsberg, S. O. Ryding, A. Forsberg, and A. Claesson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. part 2, p 825-832, 2 fig, 4 tab, 15 ref.

Descriptors: *Nutrient removal, *Phosphorus, *Lake Boren(Sweden), *Lake Ekoln(Sweden), *Eutrophication, *Water pollution control, Lake restoration, *Municipal wastes, Wastewater treatment, Tertiary treatment, Flocculation, Sweden, Lakes, Chlorophyll, Transparency, Phytoplankton, Algae, Cyanophyta, Vollenweider models, Model studies, Organic matter, Detritus, Nitrogen, Bioassay, Selenastrum capricornutum, Nutrients.

Studies in Lakes Boren and Ekoln in 1973-76 show that Sweden's program of phosphorus removal from municipal wastewater through construction of about 700 advanced treatment plants during the 1970s is effectively reducing lake eutrophication. Shallow Lake Boren has a short hydraulic residence time and is homothermal all year, while Lake Ekoln is deeper and is thermally stratified in winter and summer. Advanced wastewater treatment has reduced annual phosphorus loading by about 70% in both lakes. Phosphorus from the treatment plant at Motala has been reduced 30 to three tons/yr, and at Uppsala 100 to 20 tons/yr. Average chlorophyll-a in surface waters has decreased 50% 10 to five mg/cu m in Lake Boren, and 20 to 10 mg/cu m in Lake Ekoln. Annual phosphorus load had to be decreased 5-6 tons for each one mg/cu m of decrease in chlorophyll-a concentration. Phosphorus residence time was of the same order in both lakes, and in both transparency increased from 1.5-2.0 m as a summer average. Advanced treatment in Lake Boren was begun in May 1975, and rapid improvement was expected since it is supplied by oligotrophic water from Lake Vattern. Chemical wastewater treatment (flocculation of phosphorus) resulted in immediate improvement in the form of lower chlorophyll and higher transparency, and cyanophytes decreased significantly. In Lake Ekoln improvements included displacement of cyanophytes from Microcystis in 1970 to Oscillatoria in 1971. Vollenweider models were used to assess trophic status. (Lynch-Wisconsin)
W79-08952

RESEARCH ON RECOVERY OF POLLUTED LAKES. II. BIOMASS BUDGETS USING NATURAL AND POTENTIAL (ALGAL ASSAY) CHLOROPHYLL A,
National Swedish Environment Protection Board, Uppsala. Inst. of Physiological Botany.
S. O. Ryding, A. Claesson, and A. Forsberg.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 833-839, 3 fig, 4 tab, 2 ref.

Descriptors: *Chlorophyll, *Biomass, Budgets, *Lake restoration, *Sweden, *Nutrient removal, *Algal growth potential, *Nutrient loading, Nutrients, Biomass, Bioassay, Selenastrum capricornutum, Chlorophyta, Analytical techniques, Wastewater treatment, Phosphorus, Lake Garan(Sweden), Lake Sillen(Sweden), Lake Molkomsjon(Sweden), Lake Glaningen(Sweden), Eutrophication, Water pollution control, Algae, Mass balance, Phytoplankton, Municipal wastes.

Although phosphorus removal from municipal effluents in Sweden has been in effect for several years, water quality in some eutrophic lakes has not yet improved. Four such lakes were studied using 1973-75 data to determine reasons for the delayed recovery. This paper focuses on lake biomass budgets in terms of natural and potential chlorophyll-a as measured by Selenastrum capricornutum assays. Maximum algal growth potential (AGP) was measured as cell volume and converted to potential chlorophyll-a. Marked decrease in phosphorus input to the two shallow lakes, Glaningen (60% decrease) and Garan (75%), has led to net leakage of nutrients. Wastewater load to Lake Garan remains 66% of total load, and over half the nutrient input is still available for algal growth. Because of the lakes' highly fertilized state, it will be some time before a new equilibrium is reached between the new input and output. In the deeper lakes, Molkomsjon and Sillen, there is net accumulation of nutrients. In Molkomsjon, phosphorus concentration in wastewater effluent is still about 0.85 mg/l, and in Sillen any substantial improvement in water quality is prevented by: (1) low phosphorus reduction (30%), and (2) high degree of algal utilization of nutrients from the drainage basin, despite only 9% loading from the treatment plant and low availability of nutrients in wastewater for algal growth. Treatment plant contributions to total external loading ranged from 11-40% for nitrogen, 11-53% for phosphorus, and 9-78% for total chlorophyll-a. (Lynch-Wisconsin)
W79-08953

RESPONSE OF PHYTOPLANKTON AND PRIMARY PRODUCTION TO REDUCED NUTRIENT LOADING IN LAKE NORRVIKEN,
Uppsala Univ. (Sweden). Inst. of Limnology.
D. Ahlgren.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 840-845, 5 fig, 2 tab, 14 ref.

Descriptors: *Lake Norrviken(Sweden), *Lake restoration, *Diversion, *Phytoplankton, *Primary productivity, *Nutrient loading, *Eutrophication, *Biomass, Water pollution control, Sweden, Lakes, Algae, Sewage disposal, Chlorophyll, Carbon, Photosynthesis, Limiting factors, Seston, Net plankton, Oscillatoria agardhii, Species diversity, Cyanophyta.

A seven-year study of the recovery of Lake Norrviken, Sweden, following diversion of sewage effluent in 1969 showed that decreased nutrient supply decreased phytoplankton biomass and algal chlorophyll content, in turn resulting in lower primary production. No other restoration efforts were undertaken and recovery therefore has been entirely natural. Chlorophyll decreased from 151 mg/l in 1969 to 60 ml/l in 1976, and the Brillouin

diversity index (H sub cell) increased 0.19-2.0. Long-time dominance of phytoplankton by Oscillatoria agardhii has diminished since 1969 and other cyanophytes have increased, including Anabaena, Microcystis, and Gomphosphaeria. Diatoms and chlorophytes also increased between 1974-1976. The production/chlorophyll ratio (assimilation number) was consistent 1970-76, indicating primary production decreased proportionately to chlorophyll concentration. Estimation of the production/biomass ratio, where biomass is measured as carbon, is difficult because of problems in measuring carbon; two methods are discussed. While the first (using chlorophyll and seston) is more reliable, the second, based on net plankton analysis, is attractive because individual values always can be determined and regression analyses of the first method are often inefficient for summer values. Photosynthetic capacity expressed as production/phytoplankton carbon has diminished relative to production/chlorophyll. (Lynch-Wisconsin)
W79-08954

RESPONSE OF LAKE NORRVIKEN TO REDUCED NUTRIENT LOADING,
Uppsala Univ. (Sweden). Inst. of Limnology.
I. Ahlgren.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 846-850, 3 fig, 1 tab, 11 ref.

Descriptors: *Lake Norrviken(Sweden), *Nutrient loading, *Diversion, *Lake restoration, *Eutrophication, Phosphorus, Nitrogen, Lakes, Sweden, Water pollution control, Nutrients, Biomass, Phytoplankton, Algae, Species diversity, Primary productivity, Chlorophyll, Trophic level, Secchi disks, Sediments, Vollenweider models, Water quality indices.

Heavily eutrophic Lake Norrviken (central Sweden) has shown significant improvement in nutrient concentrations, phytoplankton biomass, species diversity, and primary productivity since sewage has been diverted from a yeast factory beginning in 1969. Based on a Secchi disk transparency index, the lake is improving at about the same rate as Lake Washington (Washington), and the time needed for both to reach their baselines may be about 15 years. According to Vollenweider criteria, critical phosphorus loading to Lake Norrviken would be 0.1-0.2 g P/sq m/yr, while normal background loading is about 0.2-0.3 g, indicating the lake was meso-eutrophic even before being polluted by sewage. In 1961-62 the yeast factory was responsible for 80% of nitrogen and 70% of phosphorus inputs to the lake. Total nitrogen loading was 66.5 g/sq m/yr in 1961-62, compared with only 2.4 g in 1976, and total phosphorus loading declined from 4.05 g/sq m/yr to 0.09 g. Sediment phosphorus retention was positive for all years 1961-62, 1970-76 except for 1971, and the average retention coefficient for 1970-76 was 0.1 (i.e., 10% of incoming phosphorus was accumulated in the sediment). Negative nitrogen retention occurred in 1971 and 1975, with an average retention coefficient of 0.2 During summer, sediment is the most important source of nitrogen and phosphorus to the water. Inorganic nitrogen has decreased more rapidly than inorganic phosphorus, and nitrogen appeared to be the primary limiting factor for phytoplankton 1970-74. (Lynch-Wisconsin)
W79-08955

SOME EFFECTS OF THE ACIDIFICATION OF SWEDISH LAKES,
National Swedish Environment Protection Board, Stockholm. Research Lab.
W. Dickson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 851-856, 5 fig, 6 ref.

Descriptors: *Sweden, *Lakes, *Aluminum, *Acidic water, *Hydrogen ion concentration, *Acid precipitation, Toxicity, Fish, Buffers, Water pollution effects, Lime, Phytoplankton, Algae, Transparency, Dry fallout, Sulfur, Water pollution treatment, Fossil fuels, Organic matter, Phosphorus, Nutrients, Geology, Salts, Bedrock, Water pollution sources.

Swedish lakes are particularly susceptible to acidification because bedrock consists mostly of slowly weathering granites, gneiss, and porphyries which render inland waters low in salts and poorly buffered. Acid atmospheric precipitation (pH 4.0-4.5) and dry deposition therefore greatly affects the lakes. Dry deposition accounts for the high sulfur concentration in lake waters of the west coast (0.3 mg/l or more). Aluminum concentrations in Swedish west-coast lake waters increased with decreasing pH from 10 to over 600 microg/l in data from summer and autumn 1976. Above pH 5.5, aluminum solubility is low and excess aluminum is precipitated. Organic matter may form complexes with aluminum, and solutions of near-neutral pH may contain several times the aluminum levels predicted from solubility data. Aluminum is an efficient precipitator of humic substances, however, resulting in increased lake transparency with increased aluminum levels at low pH, a factor contrasting with larger phytoplankton biomasses in acidic lakes. Aluminum also easily precipitates dissolved phosphorus especially at pH 5-6, and field observations often show that extremely acidic lakes have larger phytoplankton biomasses than those in the pH 5.0-5.5. range. Levels of 0.2-0.6 mg Al/l considerably increase toxicity to fish of low-pH water, with the lethal limit at about 0.7 mg/l. Liming has been a successful treatment of acidic lakes, in terms of both pH and biota. (Lynch-Wisconsin)
W79-08956

EXPERIMENTAL LAKE FERTILIZATION IN THE KUOKKEL AREA, NORTHERN SWEDEN: BUDGET CALCULATIONS AND THE FATE OF NUTRIENTS,
Uppsala Univ. (Sweden). Inst. of Limnology.
M. Jansson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 857-862, 7 tab, 6 ref.

Descriptors: *Nutrient budgets, *Phosphorus, *Nitrogen, *Lake Hymenjaure(Sweden), *Lake Magnusjaure(Sweden), *Sediments, *Subarctic, Nutrients, Lakes, Sweden, Kuokkel area(Sweden), Denitrification, Nitrogen fixation, Cold regions, Fertilization, Eutrophication, Dry fallout, Precipitation(Atmospheric), Nutrient loading, Buffers, Lake Stufsjon(Sweden).

Experimental fertilization of Lakes Hymenjaure and Magnusjaure (Kuokkel area of northern Sweden) with nitrogen and phosphorus, singly or in combination, resulted in rapid and permanent incorporation of phosphorus into sediments. Phosphorus fertilization caused increased nitrogen loading due to nitrogen fixation, and excess nitrogen accumulated in its inorganic form in lake water and was denitrified. The experimental lakes have a high phosphorus-retention capacity (80-90%) primarily through incorporation into sediments, which also holds true when phosphorus occurs in excess in lake water. For nitrogen, on the other hand, the lakes have endogenous buffering systems allowing elimination of excess nitrogen by denitrification and compensation for nitrogen-limiting situations through nitrogen fixation. Lake Stugsjon served as an experimental control. The lakes are located in a subarctic region, and have areas of 1-2 ha and maximum depths of 4.5-5.5 m. Summer mean water temperature is 8.5-10.0 C, and the lakes do not stratify. Natural nutrient concentrations are 200 microg/ N/1 and four microg P/1 in Lake Magnusjaure. Nutrients were added during the ice-free period (100-130 days/yr) at 2.02-7.04 kg P/wk (1972-75) and 89.6 kg N (1974-75) Lake Hymenjaure, and 4.64 kg P (1975) and 52.5-56.0 kg N (1974-75) in Lake Magnusjaure. Nutrient balances are given. (Lynch-Wisconsin)
W79-08957

EXPERIMENTAL LAKE FERTILIZATION IN THE KUOKKEL AREA, NORTHERN SWEDEN: CHANGES IN SESTONIC CARBON AND THE ROLE OF PHYTOPLANKTON,
Uppsala Univ. (Sweden). Inst. of Limnology.
A. Lundgren.
In: Proceedings: 20th Congress, Internationale Vereingung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 863-868, 3 fig, 9 ref.

Descriptors: *Phytoplankton, *Seston, *Detritus, *Lake Hymenjaure(Sweden), *Lake Magnusjaure(Sweden), *Carbon, *Subarctic, Biomass, Algae, Primary productivity, Lakes, Kuokkel area(Sweden), Sweden, Lake Stugsjon(Sweden), Eutrophication, Nutrients, Fertilization, Nitrogen, Phosphorus, Tripton, Cold regions, Dinoflagellates, Chrysomonads, Food chains, Oligotrophy.

Addition of inorganic phosphorus and nitrogen to subarctic Lakes Hymenjaure and Magnusjaure in Sweden's Kuokkel region produced both a quantitative increase in seston and a qualitative change from dominance of seston by detritus to dominance by phytoplankton containing high nutritive value. This change affects both filter feeders and higher trophic levels. Detritus is quantitatively important in most aquatic ecosystems and usually dominates the seston. The two lakes (plus the control, Lake Stugsjon) are naturally nutrient-poor (4-7 microg P/1 and 100-200 microg N/1), are 1-2 ha in area, and have a maximum depth of 4.5-5.5 m. Dissolved solids concentration is low, with mean specific conductivity of 15-18 micro S/cm, mean pH of 6.2-6.8, and alkalinity of 0.02-0.06 meq/1. Phytoplankton never contribute more than 10% of total sestonic carbon in Lake Stugsjon, and detrital carbon dominate with a mean of 250 microg C/1. Changes in detrital carbon were not correlated to changes in phytoplankton biomass or production, but may be governed by resuspension rate from sediments. Mean detrital carbon was 170 microg C/1 in Lake Magnusjaure and 460 microg/1 in Lake Hymenjaure, but fertilization increased sestonic carbon more than 10 times, due solely to increased phytoplankton biomass. The latter contributed 37% of sestonic carbon in Lake Magnusjaure in 1974 and 81% in 1975 after fertilization; in Lake Hymenjaure the figures were 26% and 78%, excluding the Coccomyxa coccoides collapse in September 1975. (Lynch-Wisconsin)
W79-08958

EXPERIMENTAL LAKE FERTILIZATION IN THE KUOKKEL AREA, NORTHERN SWEDEN: DISTRIBUTION, BIOMASS AND PRODUCTION OF THE SUBMERGED MACROPHYTES,
Uppsala Univ. (Sweden). Inst. of Limnology.
D. Solander.
In: Proceedings: 20th Congress, Internationale Vereingung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 869-874, 4 fig, 2 tab, 9 ref.

Descriptors: *Submerged plants, *Lake Hymenjaure(Sweden), *Lake Stugsjon(Sweden), *Biomass, *Nutrients, *Isoetes echinospora, *Sparganium, *Subarctic, Distribution, Primary productivity, Seasonal, Weight, Roots, Shoots, Eutrophication, Sweden, Kuokkel area(Sweden), Fertilization, Nitrogen, Phosphorus, Cold regions, Lakes, Water temperature.

Enrichment of Lake Hymenjaure (Kuokkel region, Sweden) with nitrogen (1975) and phosphorus (1972-75) produced few significant changes in the submerged macrophytes Isoetes echinospora and Sparganium sp. in contrast to unfertilized Lake Stugsjon. Water temperature was most important in determining maximal shoot weight for Isoetes and to a lesser extent for Sparganium. During 1972-75 both species were more dense in Lake Stugsjon than in Lake Hymenjaure; in the former Isotes ranged 1700-2200 plants/sq m (mean 2000) and Sparganium 2800-4100 plants/sq m (mean 3500), and in Lake Hymenjaure Isoetes ranged 850-1700 plants/sq m (mean 1100) and Sparganium 2000-3100 plants/sq m (mean 2500). No particular pattern was observed, except for a steady increase

of Isoetes in Lake Hymenjaure. Densities in the lakes were in the upper range among lakes; plants of both species were dwarf forms. In general, peak shoot weight and mean shoot biomass declined for both species in both lakes 1972-75 with biomass higher in Lake Stugsjon as a result of higher plant density there. An exception to the general decline was an increase of Isoetes in Lake Hymenjaure from 2.1 g dry wt/cq cm in 1974 to 3.9 g in 1975. Proportion of roots in total plant biomass of both species followed a seasonal pattern, peaking at ice break (67% in Isoetes and 51% in Sparganium). Annual shoot production of both species was normally 1.6 times seasonal mean biomass. Macrophytes did not respond to nutrient addition to the same degree as phytoplankton. (Lynch-Wisconsin)
W79-08959

EXPERIMENTAL LAKE FERTILIZATION IN THE KUOKKEL AREA, NORTHERN SWEDEN: THE RESPONSE BY THE PLANKTONIC ROTIFER COMMUNITY,
Uppsala Univ. (Sweden), Inst. of Limnology.
G. Persson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 875-880, 1 fig, 4 tab, 7 ref.

Descriptors: *Zooplankton, *Rotifers, *Nutrients, *Lake Stugsjon(Sweden), *Lake Hymenjaure(Sweden), *Conchilus unicornis, *Abundance, *Subarctic, Biomass, Eutrophication, Fertilization, Sweden, Lakes, Nitrogen, Phosphorus, Cold regions, Kuokkel area(Sweden), Kellicottia longispina, Polyarthra vulgaris, Colloteca mutabilis, Succession, Species composition, Population dynamics, Mortality, Longevity, Recruitment, Phytoplankton, Algae, Chrysophyta, Biological communities.

Phosphorus and nitrogen enrichment of subarctic Lake Hymenjaure (Kuokkel region, Sweden) generally caused no significant changes in populations of planktonic rotifers, compared with unfertilized Lake Stugsjon. Total community abundance for all years (1972-75) was typically unimodal with one summer peak dominated by Conochilus unicornis. The only notable deviation was a great Conochilus peak in 1975 in Lake Hymenjaure at 1342 ind/l, accounted for primarily by lower mortality (increased longevity) in Lake Hymenjaure, and secondarily by higher recruitment rates. Phosphorus was added to the lakes during the summers of 1972-74, and both phosphorus and nitrogen during summer 1975. Among phytoplankton the normal chrysophycean community was supplanted by one dominated by the chlorococcoid green alga Coccomyxa coccoides, a shift which occurred each year from 1973 on. Parallel increases in particulate carbon and bacteria also occurred. Of 13 rotifer species, the most important were Kellicottia longispina, Polyarthra vulgaris, C. unicornis, and Colloteca mutabilis. An annual succession occurs: (1) Keratella hiemalis and Notholca squamula appear under spring ice and disappear after ice break in mid-June; (2) with ice break C. unicornis hatches and rapidly outnumbers other species at a peak abundance of 50-300 ind/l; and (3) P. vulgaris peaks later in July accompanied or followed by K. longispina, with small populations of both persisting under winter ice. (Lynch-Wisconsin)
W79-08960

DAY TO DAY VARIATIONS IN THE PHYTOPLANKTON COMMUNITY IN THREE BROWN-WATER LAKES IN FINLAND,
Helsinki Univ. (Finland). Dept. of Botany.
V. Ilmavirta.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 881-885, 3 fig, 4 tab, 9 ref.

Descriptors: *Lake Paajarvi(Finland), *Lake Suomunjarvi(Finland), *Lake Lovojarvi(Finland), *Phytoplankton, *Primary productivity, *Weather, Lakes, Finland, *Algae, *Color, Diel migration, Biorhythms, Cryptophytes, Diatoms, Chrysophyta, Solar radiation, Clouds, Turbulence, Mixing, Biomass, Monitoring, Sampling, Chlorophyll, Shading, Oligotrophy, Eutrophication, Metabolism, Nutrients, Carbon radioisotopes.

Large daily meteorological and biological variations affecting primary productivity (such as cloud cover and irradiation, turbulence and mixing, and phytoplankton biomass) observed over six consecutive days (June 1975) in three Finish lakes demonstrate that use of single-day results could yield misleading research conclusions. The lakes were oligotrophic, mesohumic Lake Suomunjarvi; oligotrophic, brown-water Lake Paajarvi; and eutrophic, polyhumic Lake Lovojarvi. Chemical properties among the lakes differed greatly, but not within a lake. Total variation varied significantly. In Suomunjarvi and Lovojarvi phytoplankton biomass distribution by taxa showed no significant variation, but in Paajarvi an increase in the percentage of diatoms and decrease of cryptophytes was significant, due apparently to calm and sunny weather forcing cryptophyte to deeper layers, with subsequent dominance by diatoms with lower metabolic activity. Production in Lovojarvi correlated with irradiation, due to high water color and dense phytoplankton crops in the epilimnion (which also shaded subsurface waters). In Suomunjarvi production correlated with biomass and slightly with radiation (only in glass bottles). A significant correlation of production to irradiation in Paajarvi observed in previous studies was not evident, caused by the major decline in cryptophyte biomass during the last three days. Average total production in Lovojarvi ranged 564-920 mg C sub ass/sq m, in Paajarvi 125-330 mg, and in Suomojarvi 14.4-30.4 mg. (Lynch-Wisconsin)
W79-08961

SPATIAL PATTERNS OF LITTORAL MEIOFAUNA IN AN OLIGOTROPHIC LAKE,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
E. Ranta, and J. Sarvala.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 886-890, 3 fig, 1 tab, 12 ref.

Descriptors: *Spatial distribution, *Analytical techniques, *Benthic fauna, *Littoral, *Lake Paajarvi(Finland), *Meiofauna, Methodology, Lakes, Finland, Oligotrophy, Grids, Quadrats, Cladocera, Pisidium, Hydracarina, Oligochaetes, Ceratopogonidae, Model studies, Ostracoda, Tardigrada, Mapping, Random, Habitats, Aggregation, Distribution patterns, Poisson ratio.

Spatial patterns of littoral meiofauna in oligotrophic Lake Paajarvi in southern Finland were analyzed by means of grids. In October 1976 a 20 x 20-cm bottom sample was taken with a grid of 100 four-sq cm units, and in August 1976 four nested areas were sampled: (1) 4.5 sq m, (2) about 500 sq m, (3) 10,000 sq m, and (4) the 1.2-1.5 depth zone of the entire lake. Two 2.0-sq mm subsamples were taken from 10 sites in each area. Twelve taxonomic groups were identified and counted, with the total as an additional group. A Poisson distribution could be rejected for all but Ceratopogonidae, Hydracarina, and Pisidium, in which mean number of individuals per unit was low (0.93-1.64), but observed frequency distribution for all groups agreed well with the negative binomial distribution. Nonrandomness was also indicated by the variance/mean ratio, higher than 1.0 in all except the three aforementioned groups. Results suggested aggregation within the grid, which was studied with a method proposed by Krishna Iyer (1949), classifying grids units containing fewer individuals than the mean as sparse and those with more as dense. In all groups but Tardigrada and Ostracoda observed and expected numbers of joins tallied well indicating a random pattern of aggregations. Grid data were also analyzed with Goodall's method (1974) and the Skellan model (1952). Calculations based on variances for the whole lake showed that for all groups with a mean count of 10 or more/unit, 21 units, 21 units of four sq cm gives a mean abundance estimate within 40% of the true value. (Lynch-Wisconsin)
W79-08962

BIOASSAY AND IN SITU STUDIES ON PRODUCTIVITY IN A COASTAL MEROMICTIC LAKE,
Abo Akademi, Turku (Finland). Inst. of Biology.
T. Lindholm.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 891-894, 5 fig, 1 tab, 2 ref.

Descriptors: *Lake Vastra Kyrksundet(Finland), *Meromixis, *Aland Island(Finland), *Stagnant water, *Uplifting, *Eutrophication, *Primary productivity, *Lake restoration, Upwelling, Nutrients, Hydrogen ion concentration, Seas, Lakes, Finland, Bioassay, On-site tests, Phytoplankton, Algae, Baltic Sea, Bacteria, Anaerobic conditions, Oxygen demand, Deep water, Sampling, Carbon radioisotopes, Coasts.

Stagnant, anoxic, and nutrient-rich deep water in meromictic Lake Vastra Kyrksundet on Aland Island in the Baltic Sea (Finland) is uplifted by irregular influxes of Baltic Sea water, and causes remarkable increases in phytoplankton production; restoration of such coastal lakes requires special treatment of the stagnant water. Bioassay tests with natural phytoplankton communities were used to complement in-situ productivity studies in 1976. Bioassay results showed stagnant water doses of more than 0.25% by volume caused immediate decrease in carbon-14 uptake, while smaller doses produced slight, but not statistically significant increases in productivity. Addition of 1.25% always caused significant changes, with a productivity peak after two days. A 10% dose immediately reduced carbon-14 uptake to less than 10% of controls, oxygen content from 9.3 to 6.1 mg/l, and pH from 8.2 to 7.5. After four days, however, carbon-14 uptake was almost 18 times higher than controls, with high oxygen demand of 22 mg/l. Baltic water or freshwater alone had no effect on productivity. Bioassays gave more information of potential production than years of field measurements. In Lake Vastra Kyrksundet over 50% of the water volume may be anaerobic, and deep water contains several mg/l of hydrogen sulfide, ammonia, and phosphate. Such uplifting in the meromictic Aland Lakes gives them a special productivity rhythm. (Lynch-Wisconsin)
W79-08963

HELSINKI METROPOLITAN AREA WATER SUPPLY AND WATER QUALITY IN LAKE PAIJANNE,
Hydrobiological Research Inst., Jyvaskyla (Finland).
H. Harjula, and K. Granberg.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 895-899, 2 fig, 1 tab, 7 ref.

Descriptors: *Lake Paijanne(Finland), *Helsinki(Finland), *Water supply development, *Water pollution control, *Municipal water, *Water supply, *Tunnels, Water sources, Lakes, Finland, Eutrophication, Water pollution sources, Pulp and paper industry, Lake restoration, Waste water treatment, Sewage treatment, Water conveyance, Effluents, Biochemical oxygen demand, Planning, Suspended solids, Lignin, Oligotrophy.

To provide for future water supply needs of Helsinki, Finland, a tunnel will link the city with Lake Paijanne, Finland's second-largest watercourse located 120 km to the northeast. Helsinki is expected to grow from 900,000 to about 1.1 million by the year 2000, with increased water demand from four cu m/sec to 7-8 cu m/sec. Total water resources of the Helsinki region are 5.8 cu m/sec, of which 0.8 cu m/sec is provided by groundwater. The tunnel, selected in place of desalination of seawater, was begun in 1973, and the entire system will be completed by 1982. The tunnel is 30-130 m deep in good quality bedrock (granite and gneiss). For flows of 0-10 cu m/sec gravitation is sufficient, but

for flows of 10-20 cu m/sec one to three pumping stations are necessary. Eutrophication and pollution began 25-30 years ago in the naturally oligotrophic and oligohumous lake; pollution was most severe in the 1960s. Water pollution control measures have brought water quality in the southern part of the lake (where the supply intake is located) to a level approaching the natural state. The pulp and paper industry is the most serious pollution source to the lake. Numerous in-plant improvements and external effluent treatment have resulted in considerable reductions in BOD, suspended solids, and lignin; chemical wastewater treatment is planned for the late 1970s. Sewage treatment involves mechanical, chemical, and biological methods. (Lynch-Wisconsin)
W79-08964

SIGNIFICANCE OF PRIMARY PRODUCTION AND PRODUCTION OF HETEROTROPHIC BACTERIA ON THE OXYGEN CONTENT OF LAKE PAIJANNE,
Hydrobiological Research Inst., Jyvaskyla (Finland).
K. Granberg.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 900-904. 1 fig, 5 tab, 12 ref.

Descriptors: *Lake Paijanne(Finland), *Primary productivity, *Bacteria, *Oxygen, *Hypolimnion, *Pulp wastes, Productivity, Lakes, Finland, Organic matter, Sulfite mills, Heterotrophy, Phytoplankton, Algae, Lignin, Degradation(Decomposition), Sedimentation, Chemical oxygen demand, Biochemical oxygen demand, Water pollution effects.

In central Lake Paijanne, Finland, Bacterial production greatly exceeded primary production 1970-76, indicating the significance of allochthonous organic material in pollutants, specifically lignin compounds of pulp mill wastes. The lake is polluted primarily by sulfite pulp mill effluents, which inhibit primary production, and also by human wastes. High pulp mill effluent loading stimulates bacterial production. In nonhumic unpolluted lakes the main cause of hypolimnetic oxygen consumption is generally primary production, until about 30 years ago Lake Paijanne was a clear, oligotrophic lake. In cleaner waters, the effect of pulp mill organic wastes is comparable to humus, and in humic waters bacterial production can exceed primary production. The oxygen content of the hypolimnion is mainly affected by sedimentation of organic substances. Present lake COD varies 8-16 mg 02/1, with much of the COD due to the pulp mill effluents; about 50% of long-term BOD in the effluents is due to lignin compounds. The correlation coefficient between COD and lignin concentration of the water is relatively high, varying 0.57-0.83. At four stations, growing season primary production ranged from 3.4-7.1 g C/sq m in 1970 to 10.8-15.6 g in 1972 and 16.9-23.4 g in 1976, compared with bacterial production of 59.8-111.9 g C/sq m in 1970, 77.5-127.1 g in 1972, and 49.9-120.0 g in 1976. Observed oxygen concentration in the hypolimnion were 0.4-6.7 ml/1 in 1970, 0.2-8.2 in 1972, and 1.5-9.8 in 1976. (Lynch-Wisconsin)
W79-08965

INTERRELATIONSHIPS OF PHYTOPLANKTON AND ZOOPLANKTON PRODUCTION IN SOME LAKES OF CENTRAL FINLAND,
Hydrobiological Research Inst., Jyvaskyla (Finland).
L. Hakkari.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 905-909, 3 fig, 1 tab, 16 ref.

Descriptors: *Phytoplankton, *Zooplankton, *Lake Paijanne(Finland), *Primary productivity, *Bacteria, *Secondary productivity, Algae, Lake Leppavesi(Finland), Lake Kuusvesi(Finland), Lakes, Pulp wastes, Sulfite mills, Lignin, Food habits, Feeding rates, Grazing, Eutrophication, Oligotrophy, Organic matter, Herbivores, Finland, Rotifers, Tripton, Cryptomonas, Rhodomonas, Flagellates, Microorganisms, Water pollution effects.

Studies in three Finish lakes, two polluted by organic sulfite pulp mill effluents, showed that phytoplankton production varied 11-13% (meand 48%) of herbivorous zooplankton consumption, assuming the latter is four times their net production. Lowest percentages occurred in areas where primary production was inhibited by the pulp mill wastes, but even in noninhibitive contaminated areas zooplankton production exceeded phytoplankton production. In waters with lignin content over 1.0-1.5 mg/l, primary production was lower than zooplankton food demand, and thus zooplankton production in such areas was based on allochtonous organic matter or decomposed bacteria a finding matching those from natural humic waters. In areas strongly affected by the pulp mill effluents bacterial production was many times greater than phytoplankton production, and zooplankton food demand varied 21-55% of net production of bacteria and planktonic algae combined. The correlation between net phytoplankton production and herbivorous zooplankton production was significant (r=0.62), an expected result since phytoplankton were made up of large numbers of Cryptomonas spp., Rhodomonas spp., and small flagellates (all suitable food for zooplankters). Cyanophytes were almost lacking. Study lakes were moderately eutrophic Lake Paijanne and Lakes Leppavesi and Kuusvesi. Data were collected 1969-72 and 1976, primarily in Lake Paijanne. Southern Paijanne and Lake Kuusvesi are relatively uncontaminated, while Lake Leppavesi and central Paijanne receive pulp mill wastes. (Lynch-Wisconsin)
W79-08966

EFFECTS OF PULP MILL EFFLUENTS ON THE CHANGES OF FISH STOCKS IN LAKE PAIJANNE,
Hydrobiological Research Inst., Juvaskyla (Finland).
J. Nyronen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 910-913. 2 fig, 1 tab, 5 ref.

Descriptors: *Lake Paijanne(Finland), *Pulp wastes, *Water pollution effects, *Fish, Oxygen depletion, Perches, Bream, Roach, Planktivores, Effluents, Predation, Abundance, Finland, Lakes, Fisheries, Creel census, Fishing.

Pulp mill effluent pollution of central Lake Paijanne (Finland's second-largest lake, 1090 sq km) has almost eliminated planktivorous coregonid fish species, vendace and whitefish, resulting in dominance of perch, roach, and bream. Planktivorous fish made up about 60% of total catches in the lake in its natural state, an average of 17 kg/ha/yr. In 1969 the proportion was only about 7%, and average catch less than one kg/ha/yr. In the three central basins 1968-70, 59% of the total catch came from Tiirinselka (vol. 184 million cu m), 25% from Lehtiselka (vol. 468 million cu m), and 16% from Judinsalonselka (vol. 2.8 billion cu m). In 1973, 52% came from Tiirinselka, 27% from Lehtiselka, and 21% from Judinsalonselka. By 1975, 50% came from Judinsalonselka, and 25% from each Tiirinselka and Lehtiselka. The hypolimnia of the latter two have been almost anoxic since the stagnation periods of 1969. During favorable oxygen conditions in Judinsalonselka fish stock abundance increased to about 15 kg/test series/day, and the proportion of perch has increased steadily. In the other two basins test catches have decreased to 6-8 kg/test series/day. Rapid decrease in effluent loading in the early 1970s caused a rise in young classes of perch and bream, and total catches in Tiirinselka and Lehtiselka increased 40-70% compared with 1968-70. A 1974 loading increase reversed the trend, with a decrease in young perch and bream and an increase in roach. Prey-predator ratios have increased in these two basins from 3.7-4.0 to 2.6-3.0, but decreased in Judinsalonselka from 1.5-2.2. (Lynch-Wisconsin)
W79-08967

FIRST DATA ON ATP IN LAKE LEMAN,
M. L. Mackinnon, B. Chassaing, and P. Olive.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 914-920, 5 fig, 8 ref.

Descriptors: *Lake Leman(Switzerland), *Adenosine triphosphate(ATP), *Indicators, *Microorganismsism, *Biomass, Switzerland, Lakes, Methodology, Measurement, Chlorophyll, Carbon, Phytoplankton, Algae, Bacteria, Zooplankton, Nearshore zone, Offshore zone.

Sensitivity of adenosine triphosphate (ATP) as an environmental parameter was assessed through study of the distribution of total microbial biomass (TMB) in Lake Leman, Switzerland. ATP was chosen to determine TMB because: (1) it is associated only with living matter; (2) its conversion to biocarbon is fairly constant; and (3) its method of determination is fast, sensitive to the ng/l, and reproducible (range of values on triplicate analysis 15% or less). Samples were collected January and April-May 1976 and analyzed for ATP and 25 other commonly measured parameters. Conclusions: (1) the amount of living matter in the lake was negligible in January, but quite large April-May; (2) in April most of the total microbial biomass was in the top 20 m of the Grand Lac and in the top 30 m of the Petit Lac; (3) at 0.20 m there was more living matter offshore than inshore, and the ATP peak was closer to the surface at offshore than inshore stations; (4) ATP varied more offshore than between offshore and inshore; and (5) industrial urban wastes had no significant effect on development of total microbial biomass. Data on chlorophyll-a and biocarbon percentage correlated with data on ATP. Biocarbon percentage maxima occurred 5 m below the living matter maxima. Three biological zones were distinguished. Between January and April-May ATP increased 40 times, carbon assimilation rate 30 times chlorophyll-a 20 times, and POC three times. (Lynch-Wisconsin)
W79-08968

A COMPARISON OF SOME LIMNOLOGICAL CHARACTERISTICS OF TWO SMALL LAKES IN THE REGION BETWEEN THE RIVERS SAMBRE AND MEUSE,
Vrije Univ., Brussels (Belgium). Lab. voor Algemene Plantkunde en Natuurbeheer.
J. Symoens, L. Deronde, F. V. Mynsbrugge, and P. Van Geit.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 928-933, 1 fig, 3 tab, 6 ref.

Descriptors: *Limnology, *Etang des Monts Roses(Belgium), *Etang du Gland(Belgium), *Phytoplankton, *Land use, *Lithology, *History, Geology, Lakes, Belgium, Chemical properties, Watersheds(Basins), Lake morphology, Transparency, Light penetration, Algae, Periphyton, Benthic flora, Primary productivity, Biomass, Eutrophication, Diatoms, Chrysophyta, Cyanophyta, Desmids.

Recent limnological comparison of two small premodern man-made Belgian lakes, Etang des Monts Roses (first mentioned in 1755) and Etang du Gland (created about 1540), located in a region of remarkable geological and lithological diversity south of the depression formed by the Rivers Sambre and Meuse, showed that differences in limnology originally due to lithological contrasts have been reinforced by different land use. These findings contradict the hypothesis that water bodies, especially small ones, in densely populated regions of western Europe tend to evolve toward a uniform state through general eutrophication. Mont Roses has a watershed of psammites and schists, with some macigno (a sandstone rich in calcium). The basin is covered 93% by pastures, 5% by forest, and 2% by settlements. Gland has a

catchment of phyllites and quartzites, and is covered 65% by forest, 30% by agriculture, and 5% by pastures; there are practically no houses. Transparency was 45-120 cm in Monts Roses and 80 cm to the bottom (about 250 cm) in Gland. Phytoplankton in Monts Roses were dominated by diatoms in winter and spring, the cyanophyte Microcystis aeruginosa was abundant from April on, and Chlorococcales developed in May. Desmids were scarce all year. In Gland net plankton included Chrysophyceae and diatoms; the diatom Rhizosolenia longiseta was abundant in October, and Surirella robusta var. splendida from October to May. Desmidiaceae were diverse, Chlorococcales always present, and cyanophytes insignificant. Periphyton and benthic flora are also described. (Lynch-Wisconsin)
W79-08969

ROLE OF THE LITTORAL VEGETATION IN THE PHOSPHORUS AND NITROGEN BALANCE OF THE LAKE DRONTERMEER,
Ijsselmeerpolders Development Authority, Lelystad (Netherlands).
M. Loenen, and A. H. Koridon.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 935-938, 8 ref.

Descriptors: *Lake Drontermeer(Netherlands), *Littoral, *Phosphorus, *Nitrogen,*Eutrophication, *Phragmites australis, *Nutrient balance, Harvesting, Reed, Lakes, Netherlands, Nutrients, Nutrient loading, Water pollution effects, Water pollution control.

Littoral vegetation of Lake Drontermeer, Netherlands, dominated by common reed (Phragmites australis) plays a very small role in the lake's phosphorus and nitrogen balance, with less than 1% of the annual load either removed by harvesting half of the reed for thatching, or stored in newly formed underground parts. Present management of littoral vegetation through winter harvesting therefore does not contribute to nutrient removal and does not improve water quality in the eutrophic lake. Removal of 1.5-3.0% of the phosphorus load and 3.6% of the nitrogen load would be possible by harvesting all the littoral vegetation in August when nutrient content is maximum, but this alternative is impractical. Such harvesting would remove 900 kg P and 8700 kg N from the 49-ha littoral zone. Calculations were based on data collected 1975-76 in the lake, which was separated from Lake Ijsselmeer in 1957 during construction of the Flevopolders, and which became eutrophic after 1965. There is no strong correlation between nutrient accumulation in Phragmites and ambient nutrient levels. The vegetated area increased from 43 ha in 1962 to 49 ha in 1972. Nutrient load to the lake 1962-72 was estimated at 5-10 g P/sq m/yr and 25-50 g N/sq m/yr. Current load is estimated at 28,000-57,000 kg P/yr, and 143,000-286,500 kg N/yr. (Lynch-Wisconsin)
W79-08970

CHARACTERIZATION OF SPECIES DIVERSITY OF PHYTOPLANKTON ASSEMBLAGES BY DOMINANCE-DIVERSITY CURVES,
Amsterdam Univ. (Netherlands). Limnological Lab.
G. M. Hallegraeff, and J. Ringelberg.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 939-949, 4 fig, 1 tab, 25 ref.

Descriptors: *Netherlands, *Species diversity, *Phytoplankton, *Dominance-diversity curves, *Mathematical studies, *Analytical techniques, Dominant organisms, Algae, Diversity indices, Methodology, Abundance, Species evenness, Species richness, Hydrology, Trophic level, Eutrophication, Bioindicators, Oligotrophy, Niches, Ecology, Ponds, Lakes, Rivers, Barlosche Kolk(Netherlands), Pool 't Hammetje(Netherlands), Lake Maarsseveen(Netherlands), Rhine River, Bizonbaai(Netherlands), Viswater(Netherlands), Uiversnest(Netherlands), Meeuwenven(Netherlands).

Phytoplankton records from eight bodies of water in the Netherlands were used to construct dominance-diversity curves, permitting a detailed graphic description of the complete species-abundance sequence. Curves were plotted according to Whittaker (1965), with relative abundance as percentages on a log-scale on the ordinate and rank of the species, arranged in a sequence from most to least important, on a linear abscissa. Species richness (number of species) is indicated on the abscissa, and spicies evenness (with which importance is divided among species) is given by the curve's slope. Species diversity was studied by analyzing form and slope of the curves. Conclusions: (1) unitary mathematical characterization of the curves was not possible because of a wide variation of forms and slopes, ranging from geometric series through log-normal distributions to broken-stick distributions; (2) slopes for eutrophic waters generally showed greater annual variation than oligotrophic waters; (3) in floristically poor, rigorous environments (moorland pools, large stream) curves were steeply oblique, approximating geometric series; and (4) in species-rich, eutrophic environments curves were flat-sigmoid with long intermediate segments. The water bodies, covering a great range of hydrological and trophic conditions, included moorland pools (Universnest, Meeuwenven), shallow (Pool 't Hammetje, Viswater) and deep (Lake Maarsseveen) sandpits, a river dikeburst pool (Barlosche Kolk), and a sandpit (Bisonbaai) and branch (Lek) of the Rhine River. (Lynch-Wisconsin)
W79-08971

VERTICAL CHANGES IN THE FILTERING, FEEDING AND ASSIMILATION RATES OF DOMINANT ZOOPLANKTERS IN A STRATIFIED LAKE,
Hydrobiologischo Inst., Nieuwersluis (Netherlands).
R. D. Gulati.
In: Proceedings: 20th Congress; Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 950-956, 2 fig, 3 tab, 16 ref.

Descriptors: *Zooplankton, *Feeding rates, *Depth, *Filter feeders, *Lake Vechten(Netherlands), *Seasonal, *Vertical distribution, Crustaceans, Dominant organisms, Lakes, Stratification, Sand pits, Diaphanosoma brachyrum, Daphnia hyalina, Daphnia cucullata, Bosmina longirostris, Ceriodaphnia pulchella, Eudiaptomus gracilis, Phytoplankton, Algae, Chlorophyta, Chlorella pyrenoidosa, Food habits, Biological communities, Grazing, Cladocera, Copepods, Netherlands, Seston.

Vertical and seasonal changes in feeding and assimilation rates of dominant crustacean filter feeding zooplankters were studied in a small, stratified sand-pit lake, Lake Vechten, Netherlands. Maximum depth is 11.5 m, mean depth six m. The six dominant species were the cladocerans Daphnia cucullata, D. hyalina, Bosmina longirostris, Diaphanosoma brachyurum, and Ceriodaphnia pulchella, and the calanoid copepod Eudiaptomus gracilis. Food concentration (mainly Chlorella pyrenoidosa) during the study year, 1976, was highest at the end of March (six g C/sq m) and relatively homogeneous with depth. At that time zooplankton biomass was low (0.5 g C/sq m), likewise exhibited no vertical differences, and was composed mainly of Eudiaptomus. Zooplankton concentration increased to two g C/sq m by 11 May, due mainly to increases in the upper strata of Eudiaptomus, Daphnia, and Bosmina; food concentration declined by over 50% and by 25 May dropped to a level at which zooplankton biomass was comparable to its seston food. During late spring-early summer grazing pressure appeared important in governing the decline in food concentrations in the upper layers; food level then was almost the lowest of the year, despite relatively high production rates. Summer data show that differences in depth distribution of seston food were not significant; but those of zooplankton were, and that zooplankton/food biomass ratios during summer increased significantly with depth. Species' grazing rates, filtering and feeding rates, and role in the community are discussed. (Lynch-Wisconsin)
W79-08972

BULLETIN OF GASES FROM SEDIMENT, CONDITIONS, AND RELATIONSHIP TO PRIMARY PRODUCTION OF LAKES,
Max-Planck-Inst. fuer Limnologie zu Ploen (West Germany).
W. Ohle.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. part 2, p 957-962, 8 fig, 1 tab, 7 ref.

Descriptors: *Lakes, *Primary productivity, *Sediments, *Ebullition, *Bacteria, *Degradation(Decomposition), *Mud-water interfaces, Methane, Carbon dioxide, Hydrogen sulfide, Fatty acids, Gases, Oxidation, Hemmelsdorf Lake(West Germany), Pluss Lake(West Germany), Grebin Lake(West Germany), West Germany, Metabolism, Hydrogen, Nitrogen, Mud, Nitrification, Denitrification, Lake morphometry.

Ebullition of gases (mainly methane and carbon dioxide) as a result of bacterial fermentation processes in lake sediments is extremely dependent on phytoplankton production. Autochthonous productivity and bioactivity, together with morphometric conditions of the body of water, strongly affect the quantity of such mud gases and variability of their oxidation rates. This paper discusses fermentation at the mud-water interface, and gives data from Hemmelsdorf, Pluss, and Grebin Lakes (West Germany) to illustrate effects of primary production by phytoplankton. The bacterial processes are based on splitting of fatty acids as well as reduction of carbon dioxide by hydrogen (both gases produced by the breakdown of the fatty acids). Favorable conditions exist in sediments for fermentation leading to methane formation, and for high decomposition rates of organic substances. A direct relationship exists between sulfate ion supply and formation of hydrogen sulfide in the mud; methanogenesis and denitrification are inhibited by H2S and SH(-) if not strongly bound by iron compounds. In Hemmelsdorf Lake 1% of primary production is sedimented, and for anaerobic decomposition about 50% of the preliminary remains are used. In Pluss Lake only 0.5% of primary products are sedimented, and in Grebin Lake 1.0% are sedimented. (Lynch-Wisconsin)
W79-08973

SPECIFICITY OF THE ZOOPLANKTON IN SEVERAL LAKES FROM NORTHERN GERMANY WITH DIFFERENT DEGREE OF EUTROPHICATION,
Institutul de Stiinte Biologice, Bucharest (Romania).
S. P. Godeanu.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 963-968, 3 fig, 3 ref.

Descriptors: *Eutrophication, *Lakes, *West Germany, *Zooplankton, *Bioindicators, *Trophic level, Water quality indices, Kellersee(West Germany), Gr Ploner See(West Germany), Schohsee(West Germany), Abundance, Rotifers, Protozoa, Copepods, Cladocera, Biomass, Species diversity, Diversity indices, Dominant organisms, Species evenness.

Zooplankton composition was a reliable indicator of trophic level in three West German lakes, based on 1974 data. The three lakes, located on the southern edge of the zone of glacial moraines, evolved similarly until affected by recent pollution. Lake Kellersee is the most eutrophic; Lake Gross Ploner See, 15/km downstream on the Schwentine River from Kellersee, is slightly eutrophic; and Lake Schohsee, unconnected to the other two, has no sources of pollution and is mesotrophic-eutro-

phic. Kellersee always possesses a great number of zooplankton and a rich biomass, with maxima in May, July, and August; of 103 taxa, 27 are always present, 16 are incidental, and 60 are occasional. Mean dominance index value is 46.8% (McNaughton index), Shannon-Wiener diversity index is 3.16 bits/ind, and equitability index is 0.63. Lake Gross Ploner See is characterized in number and biomass by intermediate zooplankters, compared with the other lakes. Cladocerans and protozoa are abundant in spring and summer, and copepods are reduced in April and in August-September. Of 105 taxa, 24 are constant, 16 incidental, and 65 occasional. Average index values are 52% dominance, 3.04 bits/ind diversity, and 0.60 equitability. Lake Schohsee has a great increase in tintinnoids in spring, while during the rest of the year only rotifers are dominant with copepods poorly represented. Of 102 taxa, 24 are constant, 9 incidental, and 69 accidental. Mean index values are 57.6% dominance, 2.82 bits/ind diversity, and 0.57 equitability. (Lynch-Wisconsin)
W79-08974

CLIMATIC CONDITIONS AND PLANKTONIC INTERACTIONS AS FACTORS CONTROLLING THE REGULAR SUCCESSION OF SPRING ALGAL BLOOM AND EXTREMELY CLEAR WATER IN LAKE CONSTANCE,
Frankfurt Univ. (Germany, F.R.). Fachbereich Biologie.
W. Lampert.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September, 1978. Part 2, p 969-974, 4 fig, 8 ref.

Descriptors: *Lake Constance, West Germany, *Transparency, *Eutrophication, *Phytoplankton, *Succession, *Zooplankton, *Climate, Weather, Secchi disks, Temperate, Lakes, Algae, Chlorophyll, Primary productivity, Water temperature, Stratification, Phosphates, Solar radiation, Photoperiodism, Stephanodiscus hantzschii, Cryptomonas, Flagellates, Cyclops vicinus, Daphnia, Eudiaptomus gracilis, Grazing, Ecology, Predation, Limiting factors, Competition, Biological communities.

The annual sequence of spring algal bloom followed by a sudden increase in transparency in Lake Constance, on the borders between Germany and Austria, and Switzerland, depends on complex interactions between nutrient levels and amount of irradiance and grazing-predation by the zooplankters Cyclops vicinus and Daphnia sp. Under study April-July 1976 the bloom of Stephanodiscus hantzschii, Cryptomonas, and small flagellates was triggered in mid-May by high phosphate levels and strong irradiance, accompanied by a decline in transparency to under one meter and sharp peaks of chlorophyll-a and particulate carbon. During the bloom hertivorous Cyclops copepodids were the primary grazers, but consumed only 20% of net primary production. The greater herbivores, the Daphnids, were apparently controlled during the bloom by predation of adult Cyclops, which die off when the copepodids reach the fourth growth stage and are triggered into summer diapause by increasing day length, disappearing into the sediment. Daphnids, relieved of predatory pressure, increase rapidly, sometimes consuming more than the total primary production per day. The increased grazing by Daphnia and coincident phosphorus depletion ends the bloom, and transparency at the beginning of June may increase to over 10 meters in just a few days. A shift in the algal community's size composition also occurs, and by the end of June large algae make up a significant part of the primary production. (Lynch-Wisconsin)
W79-08975

NUTRIENT LOAD AND NUTRIENT BALANCE OF SOME SUBALPINE LAKES AFTER SEWAGE DIVERSION,
Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.).
A. Hamm.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 975-984, 4 fig, 4 tab, 10 ref.

Descriptors: *Nutrient loading, *Nutrient balance, *Lake restoration, *Lake Tegernsee(West Germany), *Lake Schliersee(West Germany), *Diversion,*Eutrophication, *Trophic level, Sewage disposal, Water pollution control, Nutrients, Phosphorus, Nitrogen, Lakes, West Germany, Subalpine, Vollenweider models, Sedimentation, Limnology, Climate, Oxygen depletion, Transparency, Water pollution effects.

Large-scale sewage diversion projects completed 1964-65 restored highly eutrophic Lake Tegernsee (upper Bavaria, West Germany) to oligotrophic conditions by 1973-74, but eutrophic conditions persisted in adjacent Lake Schliersee. A study of nutrient loading and nutrient balance showed that in Tegernsee the critical phosphorus loading (calculated with Vollenweider's 1976 formula was achieved by 1974, while it was not achieved in Schliersee. Contrary to previous conclusions, however, the continuing high phosphorus levels were not due to internal loading, but due rather to remaining allochthonous nutrient inputs. Nutrient balance was not significantly affected by nutrient remobilization. Removal of the last sewage inflows is in progress, and permanent water quality improvement is expected. The critical phosphorus loading for Tegernsee is calculated at 0.57 g/sq m/a, not fully reached by 1973 (1.06 g), but achieved by 1974 (0.54 g). In Schliersee the critical phosphorus load of 0.30 g/sq m/a was not reached in either 1973 (0.51 g) or 1974 (0.59 g), reflected in its continuing eutrophic characteristics. In Tegernsee, progressive improvement has been observed: (1) minimum metalimnetic oxygen levels have increased from 3.1 mg/l in 1964 to 8.3 mg/l in 1976; (2) late summer anaerobic conditions below 65 m have occurred only once in recent years (1969), and bottom oxygen content is currently never less than 4.1 mg/l; (3) transparency has improved; and (4) formerly typical Oscillatoria rubescens blooms have disappeared. (Lynch-Wisconsin)
W79-08976

ROLE OF SESTON IN THE PHOSPHATE REMOVAL IN NEUSIEDLER SEE,
Vienna Univ. (Austria). Limnologische Lehrkanzel.
A. Gunatilaka.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 986-991, 2 fig, 4 tab, 17 ref.

Descriptors: *Neusiedler See(Austria), *Seston, *Phosphates, *Nutrient removal, *Suspended solids, *Kinetics, *Absorption, Lakes, Austria, Nutrients, Chemical precipitation, Calcium carbonate, Iron hydroxide, Inorganic compounds, Orthophosphate.

Sestonic material had strong affinity for binding phosphates in the Neusiedler See, a large shallow lake in eastern Austria, during studies conducted since 1970. The lake water contained relatively high amounts of suspended material, 79-90% of which by dry weight was inorganic. Sestonic material collected during summer 1976-77 had as major mineralogical constituents (mean percent) calcite (37%), dolomite (22%), illite (19%), chlorite (11%), quartz (10%), and K-feldspar (3%). Water samples varied greatly in suspended solids (15.5-247.8 mg/l) and chlorophyll (7.6-24.4 microg/sq m) levels. Phosphate uptake patterns were observed in laboratory experiments, in 83% of which there was complete depletion of dissolved phosphates. Uptake was proportional to suspended solids concentration, verified by radiological assays. In 76% of the tests uptake started at the beginning of the experiment, but in the rest there was a lag phase of 10-20 hrs, and in 8% of these orthophosphate in solution increased 6-17 microg/l during the lag phase. Patterns fit first-order kinetic reactions better than second-order, showing that the process was governed by the amount of reactant present and that uptake depended on the availability of absorbate in solution. It is probable that a larger part of the phosphate is absorbed by the inorganic fraction of the suspended solids. This process may be explained by either: (1) co-precipitation of phosphate by calcium carbonate absorption or formation of mixed crystals, or (2) precipitation by colloidal iron hydroxide. (Lynch-Wisconsin)
W79-08977

VALUE OF SOME BIOLOGICAL INDICES IN CASE HISTORIES OF LAKES,
Nicholas Copernicus Univ. of Torun (Poland). Dept. of Hydrobiology.
J. S. Mikulski.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 992-996, 3 fig, 13 ref.

Descriptors: *Eutrophication, *Bioindicators, *Paleolimnology, *Goplo Lake(Poland), *Zooplankton, *Lakes, *Water quality indices, Evaluation, Limnology, History, Sediments, Sedimentation, Lake morphology, Water level fluctuations, Cladocera, Ecology, Species diversity, Species evenness, Poland, Bosmina coregoni, Bosmina longirostris, Chydorus sphaericus, Littoral, Water pollution effects, Biocoenosis, Periphyton, Macrophytes.

Several indices are for tracing the ecological history of lakes, particularly progressive eutrophication are evaluated. Subfossil animal remnants in sediments are useful bioindicators, as indicated by sediment samples from Goplo Lake, northern Poland. Indices are: (1) index of eutrophication (IE), based on the quantitative relationship between Bosmina coregoni and Chydorus sphaericus; (2) index of lake level oscillation (ILL), reflecting influence of such fluctuations on the relationship between pelagic and littoral zones; (3) index of lake shape regularity (ILSR), which considers effects of sedimentation and water level changes on the relationship of surface area to depth; (4) percentage relationship between Chydoridae and macrophyte formation; and (5) species diversity vs species equitability. The assumed replacement of B. coregoni by B. longirostris with increasing eutrophication applies mostly to lakes with harmonic development, unlike Goplo Lake. C. sphaericus, a littoral species, penetrates the pelagic zone with development of strong algal blooms (mainly cyanophytes). This study confirmed the relationships ILL = Bosminidae + Daphnidae/Chydoridae, and ILSR = B. coregoni + Chydoridae lacustrinae/all preserved cladoceran remains. Chydoridae connected with (1) reed periphyton (dominated by Along offinis), and (2) macrophyte groupings (dominated by Acroperus harpae, Grapholeberis testudinaria, and Eurycercus lamellatus) decreased with progressive eutrophication, and can be used as indices of littoral variations. (Lynch-Wisconsin)
W79-08978

SIGNIFICANCE OF BENTHAL FAUNA AS INDICATOR OF EUTROPHICATION DEGREE IN LAKES,
Nicholas Copernicus Univ. of Torum (Poland). Dept. of Hydrobiology.
A. Gizinski.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 997-999, 3 ref.

Descriptors: *Eutrophication, *Bioindicators, *Poland, *Lake Jeziorak(Poland), *Lake Jeziorak Maly(Poland), *Benthic fauna, *Water mass, *Water quality indices, *Trophic level, Ecology, Water pollution effects, Byszewskie Channel(Poland), Species composition, Abundance, Species richness, Equations, Potamopyrgus jenkinsi, Glyptotendipes gripekoveni, Bathophilus, Tanytarsus gregarius, Dissolved oxygen, Profundal zone, Lakes, Chironomus plumosus.

Studies in 13 lakes in northern Poland showed that the abundance of profundal fauna and its composition are useful indicators of trophic status among

lakes having similar water mass mobility. An index of mixing (IM) is proposed for water mass dynamics based on 11 lakes of the Byszewskie Channel: IM = 4.4 sq root of wave run length/mean basin depth. These lakes are moderately eutrophic, of the Bathophilus (Anthracinus type), and are similar hydrochemically but differ morphometrically. Only the profundal fauna was studied. The other two study lakes were strongly eutrophic Jeziorak and Jeziorak Maly, near Ilawa, both having very poor profundal fauna. Jeziorak Maly is more strongly degraded than Jeziorak. The number of benthic fauna taxa was lower in Jeziorak Maly (30) than in Jeziorak (36). Larvae of Tanytarsus e.g. gregarius were numerous in the Jeziorak littoral, but were absent in Jeziorak Maly. In the latter the snail Potamopyrgus jenkinsi, abundant in 1974-75, has now disappeared, but is likewise absent from Jeziorak. In Jeziorak Maly, Glyptotendipes e.g. gripekoveni larvae formed 59% of the midge population, compared with 42% in Jeziorak. Mean number of individuals/sq m of bottom fauna was 3410 in Jeziorak Maly and 2662 in Jeziorak, and seasonal change in abundance was greater in Jeziorak Maly (766-4797 vs 1108-4686). Low dissolved oxygen in the profundal zone results in very low faunal abundance and reduced number of species. (Lynch-Wisconsin)
W79-08979

CHANGES OF THE DISTRIBUTION AND NUMBER OF THE BOTTOM FAUNA AS AN EFFECT OF ARTIFICIAL LAKE AERATION,
Polish Academy of Sciences, Olsztyn.
A. Sikorowa.
In: Proceedings: 20th Congress, International Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 1000-1003, 3 fig, 8 ref.

Descriptors: *Aeration, *Destratification, *Lake Starodworskie(Poland), *Benthic fauna, *Spatial distribution, *Abundance, *Eutrophication, *Lake restoration, Lakes, Poland, Vertical distribution, Depth, Chironomidae, Oligochaetes, Chaoborus flavicans, Fish stocking, Nutrient removal, Littoral, Stratification, Dissolved oxygen, Habitats, Hypolimnion, Heleidae, Hydracarinae, Profundal zone.

Destratification by means of artificial aeration of eutrophic Lake Starodworskie in northeastern Poland resulted in favorable effects on benthic fauna. Numbers and distribution of most organisms were increased in zones previously covered by the hypolimnion. The only exception was larvae of the midge Chaoborus flavicans, whose habitat area decreased. Before aeration vertical distribution of fauna was generally restricted to a depth of 5-10 m; at 15 m only C. flavicans larvae plus one or two occurrences of Oligochaeta and Heleidae were found, and at 23 m only C. flavicans was found. By the end of the aeration period (March 1972 - September 1973) these areas were occupied by numerous Chironomidae, Oligochaeta, Hydracarinae, and Heleidae. Average monthly abundance reached a maximum of 44,327 indiv/sq m at 10 m, but increases were noted in all zones. In the littoral total number increased over five-fold, in the sublittoral three-fold, at 10-m 18-fold, at 15 m 10-fold, and at 23 m 2.5-fold. A higher rate of increase among Oligochaeta compared to Chironomidae may have been due to stronger fish predation upon the latter. Beneficial effects of aeration could be augmented through a program of fish stocking and subsequent exploitation, thus providing both nutrient removal and a protein supply. Chironomidae best illustrate the general quantitative and spatial improvement, reaching 4654-4847 indiv/sq m in the deepest zone, compared with zero before aeration. (Lynch-Wisconsin)
W79-08980

CONTRIBUTION OF FISH AND INVERTEBRATE PREDATION TO THE ELIMINATION OF ZOOPLANKTON BIOMASS IN TWO POLISH LAKES,
Warsaw Univ. (Poland). Dept. of Hydrobiology.
Z. M. Gliwicz, A. Hillbricht-Ilkowsks, and T. Weglenska.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 1007-1011, 3 fig, 7 ref.

Descriptors: *Mikolajskie Lake(Poland), *Lake Taltowisko(Poland), *Zooplankton, *Invertebrates, *Fish, *Predation, Biomass, Fish food organisms, Poland, Lakes, Seasonal, Feeding rates, Planktivores, Rotifers, Crustaceans, Copepods, Asplanchna priodonta, Leptodora kindti, Mesocyclops leuckarti, Chaoborus flavicans, Alburnus alburnus, Osmerus eperlanus, Coregonus albula, Cladocera.

Seasonal changes in zooplankton biomass elimination and consumption by fish and invertebrates were compared in eutrophic Mikolajskie Lake and mesotrophic Lake Taltowisko in Poland, with data from 1966 and 1968. In both lakes the predatory cladoceran Leptodora kindti consumed the largest portion of biomass waste. Seasonal changes in its consumption coincided most highly with changes in zooplankton biomass elimination (especially crustaceans); this predator is most important in summer. In spring (May) in Mikolajskie Lake, cyclopoid copepods, mostly Mesocyclops leuckarti, consumed the largest portion of waste (almost exclusively copepods and rotifers), while in autumn when rotifers were largely absent, the predatory rotifer Asplanchna priodonta and larvae of the midge Chaoborus flavicans played a more important role. The pattern in Lake Taltowisko was similar, though consumption by cyclopoid copepods was highest in June, and by Asplachna in September; Chaoborus was unimportant. The planktivorous fish Coregonus albula, Osmerus eperlanus, and Alburnus alburnus, consumed negligible amounts of the zooplankton biomass compared with invertebrate predators, with their share of total predator consumption relatively high only at the beginning of July in both lakes. Absolute values of elimination and consumption generally coincided seasonally in the two lakes, especially in Mikolajskie, though in Taltowisko elimination was higher than consumption throughout the year, possibly due to estimating errors. (Lynch-Wisconsin)
W79-08981

RELATIONSHIP BETWEEN THE SURFACE WATER TEMPERATURE OF TEMPERATE LAKES AND SOLAR RADIATION,
Polish Academy of Sciences, Golysz Fish Culture Station.
M. A. Szumiec.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977, Vol. 20, September 1978, Part 2, p 1012-1016. 2 fig, 1 tab, 3 ref.

Descriptors: *Solar radiation, *Temperate, *Poland, *England, *Lakes, *Water temperature, Surface waters, Mathematical studies, Heat transfer, Heat balance, Seasonal, Climate, Lake morphology, Depth, Stratification, Hypolimnion, Hydrology, Lake morphometry, Heat flow.

Data for several temperate dimictic English and Polish lakes were used to study the seasonal relationship between surface water temperature and solar radiation. The lakes differed mainly in the predominantly oceanic (English lakes) or continental (Polish lakes) nature of the local climate. The yearly water temperature (v) cycle, presented as a dependence on solar radiation flux (R), took the form of an ellipse for the study lakes. The function v(R) permits estimation of the intensity of remaining components of the water body's heat balance during specific periods of the year. The surface of the ellipse, which gives the yearly heat flux through the surface layer, increased in size with increasing influence of the continental regime and with increasing lake volume. Temperature below the thermocline depends mainly on lake hydromechanics, and is affected only indirectly by solar radiation; consequently v(R) curves for these water layers are more irregular than in shallow reservoirs or ponds. The ellipses show that in January-February there is increasing radiation but falling water temperatures, indicating that heat outflux from the lakes exceeds absorbed radiation. March-May v and R increase simultaneously, while in June diminished R increase is accompanied by intensive v increase. V continues to rise in July despite declining R, indicating an intensive heat flux to the lake resulting from lake heat processes. August-October shows a decline in both v and R, and in November an intensive heat outflux begins. (Lynch-Wisconsin)
W79-08982

DYNAMICS OF PRODUCTION OF THE PELAGIC ROTIFERS IN THREE LAKES OF DIFFERENT TROPHISM,
Akademia Rolnicza, Lublin (Poland). Zaklad Zologii and Hydrobiologii.
S. Radwan.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1017-1021. 2 fig, 10 ref.

Descriptors: *Population dynamics, *Rotifers, *Production, *Piaseczno Lake(Poland), *Bikcze Lake(Poland), *Trophic level, Zooplankton, Phytoplankton, Algae, Species composition, Poland, Lakes, Eutrophication, Mesotrophy, Dystrophy, Asplanchna priodonta, Kellicottia longispina, Keratella cochlearis, Keratella cochlearis hispida, Polyarthra vulgaris, Synchaeta pectinata, Nonnoplankton, Seasonal, Bacteria, Detritus, Food habits.

Daily production of pelagic rotifers was higher in eutrophic, polymictic Bikcze Lake than in a-mesotrophic, dimictic Piaseczno Lake or dystrophic, polymictic Brzeziczno Lake (Poland), 1971-72 and 1974. Production was lower in the latter two lakes, determined by slight differences in species composition. Trophic status has been shown to affect the proportion of nannoplankton in the rotifer diet. In eutrophic lakes where nannoplankton form a small percent of total algal biomass, high rotifer production probably depends greatly on consumption of bacterial plankton and minute detritus, whereas in lakes of other trophic levels where rotifers are less abundant the percentage share of nannoplankton in their food increases. In the lakes investigated, three rotifer species accounted for most of total production (10-100%): Asplanchna priodonta, Keratella cochlearis, and Polyarthra vulgaris. A. priodonta was the most important species in spring in all three lakes (except Brzeziczno Lake in 1971), with 63-97% of production. K. cochlearis was responsible for 68-100% of production in Piaseczno and Brzeziczno Lakes in summer-autumn and early spring. P. vulgaris was important in Bikcze Lake in early spring and summer. Keratella cochlearis hispida, Kellicottia longispina, and Synchaeta pectinata influenced production only slightly, rarely exceeding 10% of production except in the a-mesotrophic and dystrophic lakes. (Lynch-Wisconsin)
W79-08983

ESTIMATION OF THE ROLE OF ZOOPLANKTON IN THE PROCESSES OF SELFPURIFICATION,
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
I. Andronikova.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1022-1025. 1 fig, 2 tab, 8 ref.

Descriptors: *Self-purification, *Zooplankton, *Crustaceans, *Lake Krasnoye(U.S.S.R.), *Mesotrophy, *Organic matter, Cladocera, Copepods, Soviet Union, Lakes, Seasonal, Littoral, Offshore zone, Secondary production, Filter feeders, Daphnia longispina, Daphnia cucullata, Diaphanosoma brachyurum, Chydorus sphaericus, Eudiaptomus gracilis, Mesocyclops leuckarti, Mesocyclops oithonoides.

Zooplankton contribution to self-purification in mesotrophic Lake Krasnoye, Soviet Union, based on estimates for crustacean filter feeders in 1973, were sharply seasonal, with greatest activity in

July-August when zooplankton filtered the lake volume in an average of three days, and the upper 0-2 m layer in 1.0-1.5 days. In summer the pelagic zone was filtered an average of five days and the littoral in two days. Filtration decreased sharply in September, and in October it was insignificant. These figures were estimated on the basis of the filtration rate of Cladocera and Copepoda, and the seasonal pattern presented therefore probably exaggerates the summer peak because Protozoa and Rotatoa which attain maximum development in spring and autumn also contribute to self-purification. Since winter production of zooplankton is only 4% of annual production, however, the role of zooplankton in self-purification during winter is negligible. In the period May-October zooplankton removed over 7000 tons suspended organic matter from the water masses, of which 42% was mineralized. The intensity of zooplankton purifying activity is considerably higher in the littoral than in offshore waters; the littoral is thus an ecological barrier to anthropogenic inputs to the lake. Dominant filter feeders in 1973 were Daphnia longispina, D. cucullata, Diaphanosoma brachyurum, Chydorus sphaericus, and Eudiaptomus gracilis; earlier instars of Mesocyclops leuckarti and M. oithonoides were also considered. (Lynch-Wisconsin)
W79-08984

COMPARATIVE VERTICAL ZONATION AND DIURNAL MIGRATION AMONG CRUSTACEA AND ROTIFERA IN THE SMALL HIGH MOUNTAIN LAKE LA CALDERA (GRENADA, SPAIN),
Granada Univ. (Spain). Dept. of Ecology.
L. Cruz-Pizarro.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1026-1032. 3 fig, 2 tab, 11 ref.

Descriptors: *La Caldera Lake(Spain), *Vertical distribution, *Zonation, *Diel migration, *Crustaceans, *Rotifers, Lakes, Spain, Mountain lakes, Depth, Copepods, Cladocera, Biorhythms, Zooplankton, Copepodids, Nauplii, Oligotrophy, Mixodiaptomus laciniatus atlantis, Daphnia pulex, Chydorus sphaericus, Hexarthra bulgarica, Keratella cochlearis, Euchlanis.

Vertical zonation and diurnal migration of six zooplankton species were studied in August and September in La Caldera Lake, an unproductive, transparent, high mountain lake on the southern slope of the Sierra Nevada, Granada, Spain. The most significant species were the crustaceans Mixodiaptomus laciniatus atlantis, Daphnia pulex, and Chydorus sphaericus, and the rotifers Hexarthra cf. bulgarica, Keratella cochlearis, and Euchlanis sp. For the copepod Mixodiaptomus, diurnal migration was studied separately for nauplii, copepodids, and adults, and for males and females. Results showed that: (1) Mixodiaptomus migrated upward at night, with some differences by growth stage and gender; (2) the cladocerans Daphnia and Chydorus were found in deepest layers during the day, migrating upward at night but with an upper maximum reached later than Mixodiaptomus (four a.m. vs midnight); and (3) striking differences were found among rotifers, with Hexarthra showing a typical upward nocturnal migration, Keratella showing a notable tendency toward upward migration at midday and random distribution at night, and Euchlanis, exhibited a definite upward nocturnal migration, but was generally confined to the layer below seven m. Distribution of each species or copepod subdivision is presented in figures by depth and at two-hour intervals. It is noted that there have been objections to categorizing certain crustacean species as planktonic, even when collected in the limnetic zone. (Lynch-Wisconsin)
W79-08985

PHOSPHORUS, NITROGEN AND SILICA BUDGET IN LAGO DI MERGOZZO,
Istituto Italiano di Idrobiologia, Pallanza (Italy).
A. Calderoni, R. Mosello, and G. Tartari.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1033-1037. 2 fig, 4 tab, 11 ref.

Descriptors: *Phosphorus, *Nitrogen, *Silica, *Nutrient budgets, *Lago di Mergozzo(Italy), *Lake restoration, Dams, Lakes, Italy, Nutrients, Eutrophication, Mesotrophy, Vollenweider models, Trophic level, Hydraulic residence time, Hydrology, Silicon, Ammonia, Phosphates, Nutrient loading.

Phosphorus, nitrogen and silica budgets are given for Lago di Mergozzo, a deep monomictic lake in northern Italy, based on data for 1975. The critical loading level of phosphorus, which limits algal productivity in the lake, was calculated at 0.30 g/sq m/yr with Vollenweider's equations, which compares with a measured load of 0.53 g/sq m/yr. The lake is classified as mesotrophic. Eutrophic conditions observed 1969-72 are reversing, possibly due to shorter hydraulic residence time (4.7 yrs in 1975 vs 7.6 yrs 1971-74). Enrichment resulted from new sewage discharges in 1969 plus a temporary decrease in flushing rate because of construction of a new higher dam on the channel between the lake and Lago Maggiore. Nutrient inputs, outputs, and net load in g/sq m/yr for 1975 were: (1) silica-silicon 35.5, 4.6, and 30.9; (2) ammonia-nitrogen 3.01, 0.27, and 2.74; (3) nitrate-nitrogen 5.99, 5.10, and 0.89; (4) inorganic nitrogen 9.06, 5.41, and 3.65; (5) phosphate-phosphorus 0.36, 0.01, and 0.35; and (6) total phosphorus 0.53, 0.06, and 0.47. The village of Mergozzo contributed input of 8.8 g N/person/day and two g total P/person/day; phosphorus inputs came mainly (87.7%) from urban sewage. Natural watersheds contributed seven mg total P/sq m/yr. Rainwater contributed 25.6% of the inorganic nitrogen load, and natural watersheds about 45% of the total. There are no industries in the basin, and inputs from fertilizers or animal wastes are negligible. (Lynch-Wisconsin)
W79-08986

BACTERIAL ACTIVITY ON ORGANIC DETRITUS IN LAGO DI ANNONE, NORTHERN ITALY,
Istituto Italiano di Idrobiologia, Pallanza (Italy).
R. Bertoni, and C. Callieri.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1038-1044. 6 fig, 4 tab, 7 ref.

Descriptors: *Lago di Annone(Italy), *Bacteria, *Organic matter, *Detritus, *Particulate organic carbon, *Methodology, Degradation(Decomposition), Heterotrophy, Lakes, Italy, Ecology, Carbon, Measurement, Estimating, Biomass, Model studies, Regression analysis, Limiting factors, Water temperature, Fishkill, Alburnus alburnus alborella.

Heterotrophic bacterial activity can be measured by short-term variations in natural particulate organic carbon (POC) concentration and the relative increase of viable bacteria. The method is designed to overcome the major limitation of the standard approach (based on uptake kinetics of labelled organic substrates), namely that only one labelled substrate is used, which does not represent the complex pool of dissolved and particulate organic substances which constitutes natural detritus. The method was successfully applied to Lago di Annone, 50 km from Milan, composed of two small, shallow basins connected by a channel. Sampling was carried out April-October 1976. In August dead fish were removed, and the rest was incorporated into the organic detritus pool. Results showed that bacterial activity in the east basin depend upon temperature, and in the west basin upon availability of the of the particulate organic substrate. POC concentration is therefore a limiting factor of bacterial activity in this water body. POC was concentrated from samples on GF/C glass fiber filters 14 mm in diameter, precombusted at 500 C, and analyzed with a dry oxidation system, fitted with a gas chromatograph. Bacterial plate counts were made on casein-peptone-starch medium inoculated by spread plate techniques; colonies were counted after a 5-day incubation at 24 C. (Lynch-Wisconsin)
W79-08987

EFFECT OF MASS FISH MORTALITY ON ZOOPLANKTON STRUCTURE AND DYNAMICS IN A SMALL ITALIAN LAKE (LAGO DI ANNONE),
Istituto Italiano di Idrobiologia, Pallanza (Italy).
R. De Bernardi, and G. Giussani.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1045-1048. 3 fig, 7 ref.

Descriptors: *Fishkill, *Lago di Annone(Italy), *Zooplankton, *Daphnia hyalina, *Bosmina longirostris, *Population dynamics, Predation. Size, Selectivity, Alburnus alburnus alborella, Italy, Lakes, Cladocera, Fish diseases, Eutrophication, Ecology, Adaptation, Competition, Fish food organisms.

A major fishkill in August 1975 of Alburnus alburnus alborella, the most abundant planktophagous fish in the eastern basin of eutrophic Lago di Annone, northern Italy, resulted in an abrupt increase in the maximum size of its most important prey, the cladoceran Daphnia hyalina. A progressive increase in density of the size-selective Alburnus population 1954-75 had correspondingly decreased maximum Daphnia size from about 1450 micrometers to about 1000 micrometers; maximum size increased to about 1600 micrometers in 1976 after the fishkill. The western basin (connected to the eastern by a channel), was unaffected by the gill disease which caused the fish mortality; the Alburnus density there has remained fairly constant over the past 22 years at about the eastern basin's 1954 level; Daphnia maximum size also remained relatively constant at about 1400-1500 micrometers. Size-selective predation by Alburnus produced an adaptive reaction by Daphnia, especially in production of smaller sizes of primiparae. Ovigerous Daphnia of 630 micrometers were found during high fish density in the eastern basin, while in the western basin primiparae size never fell below 1000 micrometers. The fishkill caused a rapid increase in Daphnia density in the affected basin, followed by sudden breakdown due to food exhaustion (chlorophyll-a and particulate organic carbon). Bosmina longirostris abundance varied inversely with Daphnia abundance, demonstrating competition. (Lynch-Wisconsin)
W79-08988

ALTERATIONS OF THE PLANKTON IN A MUCH POLLUTED LAKE IN CENTRAL ITALY (LATIUM), THE VOLCANIC LAKE NEMI,
Stabilimento Ittiogenico, Rome (Italy).
E. Stella, L. Ferrero, and F. G. Margaritora.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1049-1054. 5 fig, 12 ref.

Descriptors: *Lake Nemi(Italy), *Water pollution effects, *Zooplankton, *Eutrophication, *Succession, *Species composition, Phytoplankton, Algae, Lakes, Italy, Fungi, Epizoites, Seasonal, Fishkill, Cyanophyta, Oscillatoria, Volcanoes, Rotifers, Copepods, Cladocera, Diversion, Cyclops abyssorum, Keratella cochlearis, Ceriodaphnia quadrangula, Eudiaptomus padanus etruscus, Macrocyclops albidus, Mesocyclops leuckarti, Leptodora kindtii.

Pollution since 1969 of volcanic Lake Nemi in central Italy by wastes from the villages of Nemi and Genzano (2500 residents), intensified by discharges from a 1000-bed hospital, has drastically reduced water quality and altered the chemical and biological characteristics of the entire basin. The lake, located in a hollow with steeply sloping sides on which the villages are situated, is 1.67 sq km in area, and has a maximum depth of 31 m. Diversion of one of the Genzano discharges and that from the hospital in February 1976 has improved conditions somewhat, but plankton remain abnormal. Zooplankton studied 1975-77 show drastic changes in species composition and distribution compared with pre-1969 studies, with disappearance of ap-

proximately 27 species previously reported except Keratella quadrata, Ceriodaphnia quadrangula, and Eudiaptomus padanus etruscus; Macrocyclops albidus was replaced by Mesocyclops leuckarti. Populations showed high densities which varied seasonally, and often only one species was present (e.g., K. quadrata in March, Cyclops abyssorum in late April, and Leptodora kindtii in June). The diversions resulted in a more regular succession of species through reappearance of several phytoplanktonic food organisms, but many zooplankton species are covered with epizoic algae (Colacium, Characiopsis) which hamper movement, and there has been massive infection of phytoplankton and zooplankton by parasitic fungi. (Lynch-Wisconsin)
W79-08989

EUTROPHICATION MODEL FOR THE MIDDLE REACHES OF THE LOIRE (MODELE D'EUTROPHISATION DE LA LOIRE MOYENNE),
Echauffement et Pollution des Eaux, Ecologie Div., Chatou (France).
E. Chalon.
Hydrological Sciences Bulletin, Vol. 24, No. 2, p 189-198, June 1979. 7 fig, 7 ref.

Descriptors: *Eutrophication, *Model studies, *Rivers, *Ecosystems, Mathematical models, Foreign research, Water temperature, Streamflow, Phytoplankton, Zooplankton, Nutrients, Nitrogen, Phosphorous, Ecological distribution, Solar radiation, Temporal distribution, Chlorophyll, Spring waters, Water quality, *France, *Loire River(France).

In order to evaluate the impact of nuclear of hydraulic works upon the middle reaches of the Loire, an ecological model was constructed and applied to the River Loire between the confluence of the River Allier and the city of Blois. This model simulated a simplified ecosystem near to a state of eutrophication. The state variables are the phytoplankton, the zooplankton, and the nutrients, nitrogen or phosphorus. The input data to the system were three-hourly average values of incoming solar radiation and the daily values of flow and water temperature. The aplication to the River Loire was restricted to phytoplankton, nitrogen, and phosphorus. The model was calibrated with weekly data measured in 1974 and 1975 at the Saint-Laurent-des-Eaux nuclear power plant, after the values of nitrogen and phosphorus input from the population bordering the river, from fertilizers spread over the basin and from the springs of the Beauce aquifer had been separately evaluated. (Humphreys-ISWS)
W79-08990

TRACE ELEMENTS IN THE SEDIMENTS OF SKADAR LAKE,
Institute of Biological Research, Belgrade (Yugoslavia).
G. Petrovic, and U. Schleichert.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1062-1066. 3 fig, 2 tab, 7 ref.

Descriptors: *Skadar Lake(Yugoslavia-Albania), *Trace elements, *Metals, *Organic matter, *Phosphorus, *Sediments, *Mine drainage, Lakes, Yugoslavia, Albania, Water level fluctuations, Water pollution sources, Littoral, Limnetic zone, Industrial wastes, Agricultural runoff, Moraca River(Yugoslavia), Crnojevica River(Yugoslavia), Rivers, Tributaries, Iron, Strontium, Barium, Titanium, Copper, Cobalt, Nickel, Chromium, Lead, Zinc, Cadmium.

Trace elements, organic matter, and phosphorus were determined for sediment samples collected 1972-73 and 1976 in the 0-15 cm layer in Skadar Lake, on the Yugoslavia-Albania border, and sources were investigated. High nickel and chromium levels were caused by nearby mining, and organic matter and phosphorus inputs derived partly from fish plant effluents. Skadar Lake, the largest of the Balkan Lakes, has a surface area of 372.3 sq km, is karstic with an average depth of only 3-6 m, and is characterized by great fluctuations in water level because of flooding of major tributaries and large inflow from cryptodepressions. The basin has in recent years been devoted to intensive industrial, agricultural, and urban uses; all wastes drain untreated into lake tributaries. The open lake exhibited lowest concentrations of all minor elements except manganese, and of organic matter and phosphorus. Highest levels of iron, strontium, barium, titanium, copper, cobalt, and especially nickel and chromium occurred at the mouth of the lake's major tributary, the Moraca River. Highest levels of organic matter, phosphorus, lead, zinc, and cadmium were found at sites influenced by the Crnojevica River. Cadmium levels were very high, reaching 10 ppm. Concentrations of nickel (25-168 ppm) and chromium (85-350 ppm) in sediments were considerably higher than in sediments of such other highly industrialized regions as in Lake Constance and Lake Michigan. (Lynch-Wisconsin)
W79-08991

ZOOBENTHOS FROM SUBLACUSTRINE SPRINGS IN LAKE SKADAR, CRNA GORA, YUGOSLAVIA,
Wisconsin Univ., Stevens Point. Coll. of Natural Resources.
G. Z. Jacobi.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1067-1077. 2 fig, 3 tab, 13 ref.

Descriptors: *Skadar Lake(Yugoslavia-Albania), *Benthic fauna, *Springs, *Cryptodepressions, *Vertical distribution, Depth, Density, Biomass, Yugoslavia, Distribution, Faunal lists, Lakes, Mollusks, Oligochaetes, Chironomidae, Tubificids, Midges, Snails, Amphipoda, Oligotrophy, Polypedium convictum, Valvata piscinalis, Pyrgula annulata, Viviparus viviparus, Chironomus plumosus, Echinogammarus scutarensis, Eutrophication, Bioindicators.

Vertical distribution, density, and biomass of macrozoobenthos was studied in seven springs, or cryptodepressions, located beneath Lake Skadar on the Yugoslav-Albanian border. The springs are concentrated along the southwestern and northern shores; formed by chemical dissolution, they are important in the water budget and to the physicochemical conditions of the lake. Though making up less than 1% of the lake volume, they yield up to 50% of the large annual fish catch. Springs studied included Radus, the deepest depression (60m), and lesser depressions Modra, Karuc, Volac, Djurovo, Nema Ime, and Krnjice. Thirty-seven taxa were identified; the highest number in one sample (19) was found at four m on the south edge of Radus. Dominant groups were Mollusca, Tubificidae, and Chironomidae, each present in over 85% of samples. Most ubiquitous species were the midge Polypedium convictum (78%), the snails Valvata piscinalis (50%), Pyrgula annulata (44%), and Viviparus viviparus (42%), the midge Chironomus Plumosus (30%), and the amphipod Echinogammarus scutarensis (30%). Highest faunal density was 8900/sq m in Djurovo at three m (99% Viviparus) and 6800/sq m in Radus at 17 m (65% tubificids, 18% Polypedium convictum). Maximum depth of several species for the lake was extended. The amphipod Synurella ambulans was the only species found at 53 m. The appearance and abundance of C. plumosus and the higher average weight of zoobenthos per sq m may indicate change in the lake's oligotrophic status. (Lynch-Wisconsin)
W79-08992

PHYTOPLANKTON PRODUCTION, PHYSICO-CHEMICAL CONDITIONS, AND NUTRIENT RELATIONSHIPS IN LAKE OHRID, YUGOSLAVIA,
Hidrobioloski Zavod, Ochrida (Yugoslavia).
B. T. Ocevski, and H. L. Allen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1078-1084. 2 fig, 12 ref. NSF GB-35374.

Descriptors: *Lake Ohrid(Yugoslavia-Albania), *Phytoplankton, *Primary productivity, *Nutrients, *Trophic level, Oligotrophy, Mesotrophy, Algae, Lakes, Albania, Yugoslavia, Water chemistry, Chemical precipitation, Absorption, Vertical distribution, Seasonal, Depth, Population dynamics, Succession, Dominant organisms, Bioassay, Carbon radioisotopes, Calcareous, Nutrient loading, Species composition, Chelation.

Lake Ohrid, on the border between Yugoslavia and Albania, had mean daily phytoplankton productivity of 291 mg C/sq m/day and an annual rate of 103.3 mg C/sq m/yr based on studies in 1974, which compare favorably with more-productive oligotrophic lakes and less-productive mesotrophic lakes. Although nutrient radiobioassay studies showed marked stimulation of productivity, indicating that continued increases in nutrient loading from the surrounding watershed could rapidly increase primary productivity rates, the calcareous nature of the lake would retard such an increase through physical-chemical mechanisms of coprecipitation and absorption onto the surface of monocarbonates. Such other factors as availability of suitable organic compounds to function as chelators are also important in suppressing phytoplankton productivity in the lake. Phytoplankton production dynamics were monitored spatially and temporally in the limnetic zone using conventional carbon-14 methods. Average monthly production rates, integrated through the trophogenic zone, varied from 63 mg C/sq m/day in December to 479 mg C sq m/day in July. Mean daily production was 36.8% higher in 1974 than in 1973. Phytoplankton undergo well-defined and highly predictable seasonal periodicity which is carefully regulated by changes in light, temperature, and nutrient availability. Changes in dominance correlated strongly with spatial and temporal changes in productivity rates. (Lynch-Wisconsin)
W79-08993

LITTORAL ZONE OF LAKE OHRID AND ITS MICROPHYTIC VEGETATION,
Hidrobioloski Zavod, Ochrida (Yugoslavia).
I. Cado.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1085-1089. 24 ref.

Descriptors: *Lake Ohrid(Yugoslavia-Albania), *Littoral, *Algae, *Aquatic plants, *Lithophytes, Ecology, Yugoslavia, Albania, Lakes, Diatoms, Chrysophyta, Navicula, Chlorophyta, Cyanophyta, Periphyton, Epilithic organisms, Epiphytes, Rhodophyta, Oligotrophy, Waves(Water), Speciation, Endolithophytes.

Microscopic vegetation of the well-defined littoral of Lake Ohrid, on the border of Yugoslavia and Albania, is described. Three characteristic zones are present: (1) supralittoral, designated the Gloecapsa-Scytonema zone; (2) eulittoral, the Microcoleus-Schizothrix-Bangia-Cladophora-Rivularia zone; and (3) infralittoral, characterized by higher species diversity. Two groups of factors affecting quantity, composition, structure, and distribution of the littoral lithophyte plant communities can be distinguished: (1) topography and other factors of specific importance to the plant composition of the total biotope, and (2) physiography and biotic factors which regulate the qualitative, quantitative, horizontal, vertical, and seasonal relationships. Three vegetative belts are identified: (1) wave splash, (2) flooded, and (3) submerged. Characteristic flora of each are described. Algal flora in Lake Ohrid is dominated by Bacillariophyceae, with 43 genera and 360 species, varieties, and forms. Navicula is the most numerous genus (79 subgeneric taxa), followed by Gomphonema and Cymbella with 25. Chlorophyta are well-represented, with 193 species and varieties, the majority planktonic. Cyanophytes are very important and Rhodophyta is represented by typical freshwater genera. Most of the lake's lithophytic algae are typical of oligotrophic waters, but some also occur in mesotrophic or eutrophic waters. (Lynch-Wisconsin)

W79-08994

ANNUAL VARIATIONS OF THE IMPORTANT ZOOBENTHIC POPULATIONS IN LAKE OHRID,

Hidrobioloski Zavod, Ochrida (Yugoslavia).
M. Tocko, and J. Sapkarev.

In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 1090-1095, 5 fig, 16 ref.

Descriptors: *Lake Ohrid(Yugoslavia-Albania), *Benthic fauna, *Oligochaetes, *Amphipoda, *Isopoda, *Depth, *Eutrophication, Vertical distribution, Hirudinea, Chironomidae, Abundance, Annual, Yugoslavia, Albania, Population dynamics, Water pollution effects, Agricultural runoff, Tubificids, Density, Pesticides, Detergents, Fertilizers.

Long-term decline (1937-73) in average annual population density of benthic fauna in Lake Ohrid (Yugoslav-Albanian border) may be the result of very slow eutrophication, but data are not sufficient for definitive analysis. Significant changes by depth also occurred. Benthic fauna are dominated by Oligochaeta, Amphipoda, and Isopoda; Chironomidae and Hirudinea (leeches) are less abundant. Data were collected in 1937-39 (summer only) and 1953-55 with an Ekman dredge, and in 1964-65 and 1972-73 with a Peterson dredge. From 1953-73 samples were taken monthly. Oligochaetes are the most abundant, having 36 taxa with Tubificidae the most numerous family. Oligochaete population fluctuated considerably, particularly in the littoral; least variation was in the profundal; Average density was 4935 ind/sq m in 1937-39, 3053 in 1953-55, 2748 in 1964-65, and 1695 in 1972-73. Increasing use of fertilizers, pesticides, and detergents in the watershed may have caused the permanent decline. Amphipods, next in importance to Oligochaeta, are represented only by the family Gammaridae (seven taxa). Average density increased from 614 ind/sq m in 1937-39 to 800 in 1964-65, then declined to 492 in 1972-73. Isopods (Asellidae, eight taxa) averaged 338 ind/sq m in 1937-39, 552 in 1964-65, and 176 in 1972-73. Leeches declined 1963-73, and chironomids 1937-73. Charts show density changes by depth. (Lynch-Wisconsin)
W79-08995

WIND, PHOSPHORUS RELEASE AND DIVISION RATE OF PERIDINIUM IN LAKE KINNERET,

Israel Oceanographic and Limnological Research Ltd., Tiberias.
C. Serruya, S. Serruya, and U. Pollingher.

In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 1096-1102, 6 fig, 17 ref.

Descriptors: *Lake Kinneret(Israel), *Winds, *Sediments, *Phosphorus, *Eutrophication, *Peridinium cinctum fa. westii, *Division rate, *Sediment-water interfaces, Lakes, Israel, Algae, Phytoplankton, Dinoflagellates, Pyrrophyta, Nutrients, Meteorology, Mixing, Reproduction, Plant physiology, Limiting factors, Nutrient loading.

In Lake Kinneret, Israel, wind pattern and intensity govern release of phosphorus from sediments and trigger an increase in the division rate of the dinoflagellate Peridinium cinctum fa. westii, resulting inmassive winter and spring blooms. Phosphorus levels depend on the duration and intensity of physical mixing, and not directly on external loading; they may be high even if external loading is reduced. Strong storms occur December-February, followed by a three-week windless period, usually in March, and then by a summer pattern of westerly periodic winds. Sediments are poor in nitrogen (0.26-0.48%) of carbonate-free dry wt. and rich in phosphorus (0.2-0.3%). The Peridinium cyst, denser than water, settles to the sediment surface where vegetative cells are born; they subsequently are recirculated by mixing. Newborn cells store large amounts of phosphorus while on sediments, and during the mixed period their intracellular phosphorus content remains high (1.0-1.5% dry wt). The windless period allows Peridinium to concentrate in the upper layers but isolates cells from phosphorus sources. The intracellular phosphorus stock is then distributed to daughter cells at each division, leading to a rapid drop in intracellular phosphorus (0.1% by May). The phosphorus limitation, together with such other factors as temperature, cause the bloom to decline. (Lynch-Wisconsin)
W79-08996

PRESENT STATE OF LAKE SEVAN (ARMENIA),

Akademiya Nauk Armyanskoi SSR, Sevan. Hydrobiological Station.
R. O. Oganesian.

In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1103-1104. 1 ref.

Descriptors: *Lake Sevan(USSR), *Eutrophication, *Water level fluctuations, *Succession, *Bioindicators, *Oligotrophy, Lakes, Soviet Union, Benthic fauna, Phytoplankton, Algae, Zooplankton, Dissolved oxygen, Nutrients, Fish, Productivity, Biomass, Cyanophyta, Diatoms, Crustaceans, Chironomidae, Solar radiation, Chrysophyta, Rotifers, Copepods.

Progressive eutrophication of oligotrophic Lake Sevan, Armenia, U.S.S.R., has been the result of a continuing decrease in water level (17 m to date). The lake formerly was characterized by high hypolimnetic oxygen (> eight mg/l), very low nitrogen and iron levels, no nitrogen fixation, phytoplankton dominated by small diatoms, low primary production, and dominance of zooplankton by copepods and fish by trout. At present (1976) the lake exhibits summer hypolimnetic oxygen depletion, increased nitrogen (0.14 mg/l annual mean) and iron (0.012 mg/l) content, high phosphate levels (0.06 mg/l), replacement of smaller by larger diatoms, appearance of cyanophytes (Anabaena, Aphanizomenon), primary production typical of eutrophic waters, increased role of rotifers (680 mg/cu m) and dominance by Cyclops (5270 mg/cu m) in zooplankton, and replacement of trout by Coregonus. Among benthic fauna, Chironomidae are now dominant, and biomass of the crustacean Gammarus lacustris decreased three-fold. A tunnel is under construction to reroute the Arpa River into Lake Sevan, which will increase the lake's water level, increase the hypolimnion volume, and improve the oxygen regime of the entire water column. Creation of the Sevan National Park will assist in preserving and restoring the lake. Relatively high water transparency led to increasing productivity of all main trophic levels. Phytoplankton production increased from 1.27 g O/sq m in 1958 to 8.5 g in 1976 (daily averages), with a ten-fold increase in biomass to six mg chl-a/cu m. (Lynch-Wisconsin)
W79-08997

CIRCULATIONS OF ORGANIC SUBSTANCE AND BIOLOGICAL PRODUCTIVITY OF LAKE BAIKAL,

Limnologicheskii Inst., Irkutsk (USSR).
G. I. Galazy.

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Descriptors: *Lake Baikal(USSR), *Organic matter, *Primary productivity, *Phytoplankton, *Photosynthesis, *Oligotrophy, Soviet Union, Lakes, Circulation, Algae, Zooplankton, Seals, Fish, Productivity, Limiting factors, Nitrates, Mesotrophy, Biomass, Seasonal, Carbon, Trophic level, Diatoms, Chrysophyta.

Phytoplankton photosynthesis is responsible for 90% of organic matter entering the trophic chains in Lake Baikal (U.S.S.R.). Absolute values of primary production per unit of water volume characterize the lake as oligotrophic, but thickness of the trophogenic layer results in high primary production values per sq m of lake surface, comparable to mesotrophic waters. Photosynthesis occurs to 50-70 m depth, with the compensation layer at 15-25 m. In summer, intensive photosynthesis occurs at 15 m. Annual primary production in the trophogenic layer averages 127 g C/sq m (range 66-158 g); the lakes southern and central parts are the most productive. Biomass in highly productive years in the trophogenic layers ranges 130,000-800,000 tons/yr, with an annual average of 200,000 tons fresh wt. Fresh wt of algae averages 6.5 g/sq m, or 260 g/cu m. Baikal waters are low in organic matter content (1.0-1.6 mg/l organic carbon). Nitrates limit photosynthesis August-September, and decrease to zero in the trophogenic layers. The production/biomass ratio varies greatly over a year, with an average of 304, a value approaching ocean ratios. Up to 75% of all new organic matter is decomposed annually. In the limnetic zone 92 phytoplankton species have been identified, dominated during biomass maxima in spring by diatoms, peridineans, or chrysophyceans. The lake's antiquity accounts for its well-balance ecosystem. Zooplankton, fish, and the Baikal seal are briefly discussed. (Lynch-Wisconsin)
W79-08998

ON THE GENESIS OF THE ROTATORIAN FAUNA ON BAIKAL LAKE,

Akademiya Nauk SSSR, Leningrad. Zoologicheskii Inst.
L. A. Kutikova.

In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1978, Part 2, p 1108-1110. 12 ref.

Descriptors: *Lake Baikal(USSR), *Rotifers, *Zooplankton, *Benthic fauna, *Littoral, *Limnetic zone, *Paleolimnology, Ecology, Lakes, Soviet Union, History, Endemic, Zonation, Evolution, Species composition, Water temperature, Dissolved oxygen, Seasonal, Palearctic, Holarctic, Siberia(USSR), Coasts.

The rotifer fauna of Lake Baikal, U.S.S.R., differs from other faunal groups in the lake in that it is based not on endemic species, but rather on a Palearctic complex of species in both the limnetic and littoral zones. Baikal faunas are usually characterized by deep endemism, with endemic species inhabiting the open lake and forming the seasonally unique Baikal fauna, while a Siberian-European complex typical of Siberian eutrophic lakes inhabits the shallow littoral zones of bays, gulfs, and river estuaries. Among Lake Baikal rotifers, the Palearctic species (ancient paleolimnetic intruders that inhabited the pre-Baikal Lakes) and endemic species (mesolimnetic) probably have always inhabited Baikal simultaneously, but have been seasonally isolated from one another because of different ecological needs. Specifically, the endemic species need a relatively constant and low temperature (4-6 C) and high dissolved oxygen, and their population maximum occurs in early spring. The Siberian-European complex of the Baikal rotifer fauna cannot be synonymized with the coastal complex; the former includes not only the truly coastal thermophilic and mesotrophic species but also the cold-stenothermic, oligotrophic, planktonic, and littoral forms on which the rotifer fauna is based. In 1972-74, 105 rotifer species were found, 27 endemic. The littoral contains 81% of the endemic fauna. (Lynch-Wisconsin)
W79-08999

SALINITY INTRUSION INTO LAKE SONGKLA, A LAGOONAL LAKE OF SOUTHERN THAILAND,

Prince of Songkla Univ. (Thailand). Faculty of Natural Resources.
D. Limpadanai, and P. Brahamanonda.

In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoreoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1111-1115. 2 fig, 1 tab, 17 ref.

Descriptors: *Lake Songkla, *Salinity, *Saline water intrusion, *Lagoons, *Water pollution ef-

fects, Lakes, Thailand, Tidal effects, Channel improvement, Irrigation, Rainfall, Heavy metals, Osmoregulation.

Seasonal salinity fluctuations in lagoonal Lake Songkla, southern Thailand, are caused by a month of heavy rainfall (up to 800 mm) toward the end of each year, which coincides with salinity levels as low as zero ppt, and tidal flow into the lakes southern inlet, resulting in maximum salinity levels of 32 ppt. Salinity in the southern basin has increased since 1967 from a maximum of 20 ppt to the current 32-ppt maximum, due primarily to dredging of the outlet channel. Dredging removed 2.1 million cu m of silt in 1967 and 0.5 million cu m in 1972. Water resources development in the western part of the watershed, including paddy field irrigation, is not a major contributor to increased salinity. Effects of salinity increase on aquatic organisms in the lake are unknown, but other studies indicate aquatic organisms tolerated certain amount of salinity change. However, if osmoregulation is altered by such influences as heavy metals, mortality may result, as has been demonstrated for isopod crustaceans. Salinity was monitored at four stations; data are given for 1965-67, 1969, and 1971. The maximum salinity of 32 ppt was recorded in September, with a secondary peak in April. Zero ppt occurred in December and January. (Lynch-Wisconsin)
W79-09000

MACROINVERTEBRATES AS AN IMPORTANT SUPPLIER OF NITROGENOUS NUTRIENTS IN A DENSE MACROPHYTE ZONE IN LAKE BIWA,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
T. Miura, K. Tanimizu, Y. Iwasa, and A. Kawakita.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1116-1121. 2 fig, 1 tab, 9 ref.

Descriptors: *Lake Biwa(Japan), *Nitrogen, *Shrimp, *Snails, *Elodea densa, *Nutrient budgets, *Excretion, Japan, Lakes, Invertebrates, Nutrients, Cycling nutrients, Limiting factors, Primary productivity, Ammonia, Photosynthesis, Paratya compressa, Palaemon paucidens, Macrobrachium nipponense, Sinotaia histrica, Seimisulcospira decipiens, Biomass, Equations, Seasonal, Symbiosis.

Three shrimp species in a dense community of the aquatic macrophyte Elodea densa in Japan's Lake Biwa were important suppliers of ammonia and other forms of nitrogen during June and July when Elodea production was highest. Two snail species, though accounting for twice as much biomass in terms of nitrogen as the shrimp, had very low nitrogen excretion rates and were thus less important as nitrogen suppliers. The shrimp (Paratya compressa, Palaemon paucidens, and Macrobrachium nipponenense) and snail (Sinotaia histrica and Semisulcospira decipiens) dominate animal biomass in the Elodea community. Seasonal fluctuation of the net production rate of Elodea was studied 1974-75; daily net production rate during the most productive month (June) was 13.8 g dry wt/sq m. And annual net production was 1044 g dry wt/sq m (36.5 g N/sq m), and annual loss was 1095 g dry wt/sq m (38.3 g N/sq m). The shrimp supplied 61 mg N/sq m/day in June, or about 60% of the negative value of the nitrogen balance. Among freshwater crustaceans 62-70% of nitrogen excretion is ammonia, compared with 42% among freshwater snails. Allochthonous nutrients were not likely to have reached the plant zone due to the plant's obstruction of water exchange, and supply of nitrogenous nutrients from nitrogen regeneration from decaying plants was inadequate to meet demand in June and July. Neither the omnivorous-carnivorous shrimp nor the snails (which graze attached algae) graze the Elodea. (Lynch-Wisconsin)
W79-09001

DISTRIBUTION OF PHOSPHATE, NITRITE AND SILICATE IN LAKE EDKU, EGYPT,
Alexandria Univ. (Egypt). Dept. of Oceanography.
M. A. H. Saad.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1124-1130. 2 fig, 3 tab, 29 ref.

Descriptors: *Phosphates, *Nitrites, *Silicates, *Lake Edku(Egypt), *Nutrients, *Distribution, *Seasonal, Egypt, Lakes, Saline water intrusion, Saline lakes, Brackish water, Mediterranean Sea, Fisheries, Phytoplankton, Algae, Diatoms, Chrysophyta, Winds, Denitrification, Degradation(Decomposition).

During a 1969-70 study, distribution of phosphate, nitrite, and silicate varied seasonally in Lake Edku, a shallow brackish-water lake 30 km northeast of Alexandria, Egypt, and connected to the Mediterranean Sea by a narrow passage, Boughaz El-Maadiah. The lake's fishery is of considerable economic importance. Depth ranges 50-150 cm, and lake water is derived primarily from three drains and the sea. Six sample sites represent all parts of the lake. Average phosphate values ranged from 45.3 mu-g PO4/l in March to 518.3 mu-g in September, nitrite from 9.3 mu-g NO2/l in February to 82.8 mu-g in July, and Silicate from 1.0 mu-g SiO2/l in March to 5.9 mu-g in August. At the six stations, phosphate ranged from a low of nine mu-g to a high of 84.0 mu-g, nitrite from 4.9-204.0 mu-g, and silicate from 0.6-7.5 mu-g. Seasonal nutrient variations have not been correlated with phytoplankton production or lake turnover rate since nutrient concentrations are mainly controlled by seasonal fluctuations in drainage waters entering the lake. Average nutrient values were higher at the three stations located near the drains, while stations near the seawater inflow had lower values. Phosphate level increases are attributable to increased phytoplankton decay, nitrite increases are due to denitrification, and silicate levels are strongly influenced by diatom population. (Lynch-Wisconsin)
W79-09002

LIMNOLOGICAL AND PALEOLIMNOLOGICAL DATA ON THE BALE MOUNTAIN LAKES (ETHIOPIA),
Vienna Univ. (Austria). Zoologisches Inst.
H. Loffler.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1131-1138. 4 fig, 2 tab, 19 ref.

Descriptors: *Lakes, *Limnology, *Paleolimnology, *Bale Mountains(Ethiopia), *Mountain lakes, *Africa, Ethiopia, Zooplankton, Phytoplankton, Algae, Benthic fauna, Ostracoda, Daphnia obtusa, Copepods, Cladocera, Glacial lakes, Garba Guratsch(Ethiopia), Cold regions, Diatoms, Chydorus, Hora Orgona(Ethiopia), Biogeography, Cores, Campylodiscus noricus, Chrysophyta, Palearctic.

The Bale Mountains of Ethiopia are the northernmost high mountain range in Africa containing lakes situated above the timberline and therefore subject to cold polymictic conditions. Fifteen of the area's 100 lakes and ponds were investigated April 1976 to obtain paleolimnological information and to study zoogeographical relationships to similar lakes further south in East Africa. Most of the lakes were formed or influenced by glaciation. Water temperatures in April range 10-12 C in the larger lakes, Hora Orgona and Garba Guratsch, and 0-29 C in shallow ponds. Virtually no rotifers or phytoplankton (except nannoplankton) are present. Zooplankton are uniform and composed exclusively of palearctic species: Daphnia obtusa, Arctodiaptomus (Rhabdiaptomus) n. sp., and Megacyclops viridis. The heavily pigmented D. obtusa represents the first pigmented Daphnia in Africa, and must be considered one of the earliest colonists of the Bale lakes. By contrast, benthic Cladocera, benthic copepods (except Paracyclops fimbratus), and ostracods belong to African taxa, demonstrating the close relationship between fauna of the genera Macrothrix, Leydigia, Alona, Alonella, and Chydorus. A core taken from a shallow lake showed Daphnia obtusa to have been continuously pigmented from its first appearance. Campylodiscus noricus was the most common diatom in the core, and is still abundant. (Lynch-Wisconsin)
W79-09003

CASE STUDIES OF LAKE ECOSYSTEMS AT DIFFERENT LATITUDES. THE TROPICS. THE LAKE GEORGE ECOSYSTEM,
City of London Polytechnic (England). Dept. of Biological Sciences.
M. J. Burgis.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1139-1152. 4 fig, 4 tab, 85 ref.

Descriptors: *Lake George(Uganda), *Ecosystems, *Tropical regions, *Stability, *Biological communities, *Cycling nutrients, *Seasonal, Lake morphology, Climate, Uganda, Lakes, Cyanophyta, Algae, Phytoplankton, Microcystis, Herbivores, Zooplankton, Thermocyclops hyalinus, Nitrogen, Nutrients, Rainfall, Stratification, Fish, Grazing, Feeding rates, Food habits.

Lake George, Uganda, is an uncharacteristically stable tropical lake, a product of its equatorial position, morphology, local geography, and climate. Whereas most tropical lakes have marked seasonal changes, Lake George experiences little seasonal change in solar radiation, day length (12.1 hrs), temperature, wind, flow through, and depth (mean 2.4 m, maximum 3.0 m). The lake stratifies and mixes in a daily cycle, and is protected by mountains. An important feature of the Lake George biological community is its dominance by herbivores (such as the cyclopoid copepod Thermocyclops hyalinus) able to use blue-green algae as food, especially Microcystis. Fish biomass is also dominated by herbivores (60%), Sarotherodon niloticus (Tilapia nilotica) and Haplochromis nigripinnis, which feed directly on the phytoplankton. Both the planktonic and fish herbivores exhibit diurnal feeding cycles. However, a relatively small proportion of primary production is converted into consumer production, indicating a rather inefficient system. Gross primary production is estimated at 82,400 kJ/sq m/yr, and herbivore production at 650 kJ/sq m/yr. The zooplankton population is remarkably constant seasonally, not the case with all tropical lakes including Lake Edward (Amin) with which Lake George is connected. The very large phytoplankton standing crop is greatly and continuously dependent on internal nutrient recycling, probably another function of the system's stability. (Lynch-Wisconsin)
W79-09004

GROWTH AND PRODUCTION OF AQUATIC MACROPHYTES IN A SOUTH TEMPERATE LAKE CLIMATE,
Rhodes Univ., Grahamstown (South Africa). Inst. for Freshwater Studies.
C. Howard-Williams.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1153-1158. 3 fig, 12 ref.

Descriptors: *Macrophytes, *Chara globularis var. krausii, *Potamogeton pectinatus, *Swartvlei(South Africa), *Primary productivity, *Plant growth, Phytoplankton, Algae, Lakes, Saline lakes, Coasts, South Africa, Phenology, Biomass, Color, Phosphorus, Sediments, Nutrients, Fish reproduction, Habitats, Limiting factors, Light penetration, Estuaries, Fisheries, Temperate.

Though maximum phytoplankton production in Swartvlei, a South African coastal saline lake, is the lowest recorded for an African water body (5-13 mg C/cu m/hr), maximum Potamogeton pectinatus productivity (16 g/sq m/day) and biomass in the littoral are among the highest as described in the literature. The shallow littoral (< three m) supports dense beds of Potamogeton (0.64 sq km in water 100-300 cm deep) and Chara globularis var.

krausii (1.61 sq km in water 30-100 cm deep). In the many South African coastal lakes with sea connections, such as Swartvlei, macrophyte beds help these systems function as marine fish nurseries. Besides directly providing juvenile fish with shelter and food, the plants are a habitat for an extremely large invertebrate population which provides additional food. In view of its low planktonic production, Swartvleis suitability as a fish nursery seems largely dependent on its high macrophyte production. Phytoplankton production appears limited by poor light transmission of the brown water (from humic compounds in inflowing rivers) and by very low dissolved phosphorus levels, whereas Potamogeton's photosynthetic tissue is concentrated in the upper 50 cm of the water column and the plant can absorb nutrients from the phosphorus-rich littoral sediments. Chara total production is calculated at 423 million g/yr, and for Potamogeton 1.6 billion/g/yr, compared with 700 million g for plankton. The growth cycle of potamogeton is described. The greatest proportion of lake organic matter inputs come from the littoral. (Lynch-Wisconsin)
W79-09005

FACTORS LIMITING ALGAL GROWTH ON THE SUB-ANTARCTIC ISLAND MARION,
Orange Free State Univ., Bloemfontein (South Africa). Inst. for Environmental Science.
J. U. Grobbelaar.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1159-1164. 4 fig, 1 tab, 14 ref.

Descriptors: *Marion Island, *Limiting factors, *Algae, *Lakes, *Cold regions, *Nutrients, *Water temperature, Islands, South Africa, Nitrogen, Phosphorus, Periphyton, Benthic flora, Phytoplankton, Species diversity, Bioassay, Algal growth potential, Gentoo Lake(South Africa), Skua Lake(South Africa), Albatross Lake(South Africa), Chlorophyll, Adaptation, Chlorella, Scenedesmus, Plant growth, Habitats.

Algal growth in several freshwater lakes on sub-Antarctic Marion Island, in the Prince Edward Island group about 600 miles south of Africa, is limited primarily by low temperatures and poor water quality. Most of the algae have low chlorophyll content, and survive in a hostile environment. Algal growth potential (AGP) bioassays shows that both nitrogen and phosphorus are limiting in the lakes, which possess extremely low AGPs in surface waters. Average annual temperature on the island is 5.1 C, precipitation exceeds 2500 mm/yr, and average wind speed is 27 km/hr. Marion Island is located at 46 degrees 53' S and 37 degrees 45' E. Flora and fauna have low species diversity, which, together, with a general lack of endemic forms, is attributed to glaciation and to the island's young geological age and westerly position in the Kerguelen Province, signifying a migration route against prevailing westerly winds and oceanic currents. Planktonic algae are scarce in the freshwater habitats, but periphyton and benthic algal felts and mats are abundant. In laboratory tests both Chlorella sp and Scenedesmus sp exhibit maximum growth rates at 22 C. Absorption of radiant energy by algae to achieve temperatures above that of their surroundings is very important in cold environments; on Marion Island temperature differences up to 4.5 C were measured between benthic algal felts and overlying waters. Skua Lake's AGP is 6.0% of Chu's medium no. 10, Skua Lake no. 4 is 5.9%, Albatross Lake no. 1 is 0.6%, study area no. 1 lava-lakelet is 5.8%, and Gentoo Lake is 12.3%. (Lynch-Wisconsin)
W79-09006

LIMNOLOGY OF VICTORIAN SALT LAKES, AUSTRALIA,
Adelaide Univ. (Australia). Dept. of Zoology.
W. D. Williams.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1165-1174. 3 fig, 71 ref.

Descriptors: *Saline lakes, *Limnology, *Aquatic animals, *Water chemistry, *Victoria(Australia), Lakes, Australia, Osmoregulation, Ecosystems, Temperate, Salinity, Hydrogen ion concentration, Dissolved oxygen, Macrophytes, Phytoplankton, Algae, Biological communities, Species diversity, Species composition, Reviews, Ions, Halotolerance, Lake Bullenmerri(Australia), Lake Corangamite(Australia), Lake Beeac(Australia), Lake Werowrap(Australia), Halophilic animals.

Recent studies of salt lakes (3% salinity) in Victoria, Australia, are summarized. These lakes are of particular interest because they vary widely in salinity (> 1 to 350%), are ionically homogeneous, have distinctive and markedly endemic fauna, and range from shallow temporary water bodies to deep permanent lakes. The lakes are most numerous in an endorheically drained, flat, temporate region 150 km west of Melbourne, largely a broad volcanic basaltic plain of Quaternary age. Summers are warm and dry, winters wet and cool. Surface water temperatures range 10-24 C in the deeper lakes, and 10 C to over 30 C in the shallow lakes. The consistent pattern of ionic dominance is Na Mg K Ca:Cl SO4 HCO3 + CO3. The pH of all lakes exceeds eight, sometimes nine. The lakes are well-buffered. Salinity and oxygen are strongly correlated, and species diversity is inversely correlated with salinity. Three faunal groups can be distinguished: (1) halobionts (50-100% salinity), including an anostracan, three ostracods, three copepods, an isopod, a chironomid, and a ceratopogonid; (2) halophiles (10-60% salinity, including three rotifers, two copepods, a cladoceran, a cnidarian, and a gastropod; and (3) salt-tolerant freshwater forms (< 1-20% salinity), a copepod, amphipods, odonates, and corixids. Botanical investigations have been few; the most important macrophytes are species of Ruppia, Lepilaena, Potamogeton, and Enteromorpha. (Lynch-Wisconsin)
W79-09007

MICROBIAL ACTIVITY AND BIOMASS RELATIONSHIPS IN 26 OLIGOTROPHIC TO MESOTROPHIC LAKES IN SOUTH ISLAND, NEW ZEALAND,
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Dept. of General Limnology.
M. J. Spencer.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1175-1181. 4 fig, 26 ref.

Descriptors: *Biomass, *Trophic level, *New Zealand, *Lakes, *Heterotrophic potential, *Microorganisms, Bacteria, Oligotrophy, Mesotrophy, Eutrophication, South Island(New Zealand), Heterotrophy, Phosphorus, Nitrogen, Nutrients, Chlorophyll, Adenosine triphosphate, Glacial lakes, Mixing.

Relationships between microbial activity and biomass parameters are described for 26 lakes on South Island, New Zealand, ranging from oligotrophic to mesotrophic. Microbial activity was determined by heterotrophic potential technique (maximum rate of uptake and respiration of carbon-14 glucose, or V sub max). Biomass parameters include direct bacterial counts, microbial adenosine triphosphate (ATP), total nitrogen (TN), and total phosphorus (TP), measured during summer studies (1976-77) of trophic status in the lakes, located near Canterbury. On the basis of heterotrophic potential, 15 lakes are classified oligotrophic and 11 mesotrophic. V sub max correlates well with total bacterial numbers, total nitrogen, and total phosphorus. Grouping the lakes by V sub max vs microbial ATP concentrations yields classifications consistent with trophic level. Chlorophyll-a and bacterial numbers correlate significantly with microbial ATP, TN, and TP concentrations for all lakes. The lakes are predominantly glacial, and range large/deep-small/shallow. Strong winds usually prevent thermal stratification. Heterotrophic potentials range 0.00032-0.0833 mu-g glucose/l/hr. Chlorophyll-a concentrations are generally less than four mu-g/l, but two lakes have concentrations of about seven mu-g/l. (Lynch-Wisconsin)
W79-09008

EFFECTS OF DIFFERENT SILT LOADS AND OF HYDRO-ELECTRIC DEVELOPMENTS ON FOUR LARGE LAKES,
Canterbury Univ., Christchurch (New Zealand). Dept. of Zoology.
V. M. Stout.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1182-1185. 2 fig, 1 tab, 1 ref.

Descriptors: *New Zealand, *Lakes, *Siltation, *Turbidity, *Environmental effects, *Hydroelectric powerplants, Waitaki River(New Zealand), Lake Tekapo(New Zealand), Lake Pukaki(New Zealand), Lake Ohau(New Zealand), Lake Benmore(New Zealand), Chlorophyll, Phytoplankton, Algae, Zooplankton, Copepods, Cladocera, Desmids, Diatoms, Oligotrophy, Secchi disks, Baseline studies, Mixing, Chlorophta, Chrysophyta, Glacial lakes, Rivers.

Phytoplankton and zooplankton composition in four large lakes in the Waitaki River system (South Island, New Zealand) are strongly related to turbidity levels, determined by silt inputs from inflowing rivers. Planned modifications to increase hydroelectric production will alter flow among the lakes, and therefore are likely to change the biological regimes. Lakes Tekapo, Pukaki, and Ohau are natural oligotrophic glacial lakes in the river's headwaters, and are influenced most by inflowing silt. Lake Benmore, uppermost of three impoundments, receives outflows from the three upper lakes; modifications will reduce flow into Benmore from Tekapo and Pukaki. Water in the three upper lakes has low chemical content, and strong winds reduce stratification; Benmore is shallower and more strongly stratified. Secchi disc readings average 9.36 m in Ohau, 4.99 m in Tekapo, and 0.57 m in Pukaki. Chlorophyll-a content is low in all lakes (often less than one mg/cu m), and lowest in Tekapo. Tekapo and Pukaki have few phytoplankton species dominated by diatoms. Ohau, the clearest lake, has a more varied algal flora dominated by desmid chlorophytes. In Benmore a Pukaki-like phytoplankton gave way to one resembling that in Ohau when flow was reduced from Pukaki and Tekapo. Zooplankton populations are dominated by rotifers in Pukaki, by the calanoid copepod Boeckella dilatata in Tekapo, and by the cladoceran Bosmina meridionalis in Ohau. (Lynch-Wisconsin)
W79-09009

ZOOPLANKTON OF LAKE VALENCIA (VENEZUELA) I. SPECIES COMPOSITION AND ABUNDANCE,
A. de Infante.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1186-1191. 4 fig, 2 tab, 7 ref.

Descriptors: *Lake Valencia(Venezuela), *Species composition, *Zooplankton, *Abundance, *Eutrophication, *Water pollution, Species diversity, Venezuela, Lakes, Faunal lists, Water levels, Dessication, Nutrients, Salinity, Saline lakes, Tropical regions, Alkalinity, Phosphorus, Phytoplankton, Algae, Rotifers, Copepods, Cladocera, Nutrient loading, Succession, Water pollution sources.

Pollution of Lake Valencia, the largest natural lake in Venezuela (350 sq km), by streams and canals containing domestic, industrial, and agricultural wastes is causing rapid dessication and eutrophication. This paper reports the first zooplankton evidence for eutrophication. In the last 250 years water level has declined more than 20 m and salinity has increased eight-fold. Lake Valencia has one of the highest phosphorus loading rates among large tropical lakes on an areal basis. Zooplankton abundance almost tripled 1968-1976. The number of species increased from 24 in 1956 to 40 in 1976 though the change may be due in part to more intensive sampling in the 1976 survey. Rotifers increased the most in abundance 1968-76; Ketatella americana remains the most abundant species and tripled in density. Brachionus spp also increased

dramatically; B. calyciflorus is the most abundant. Brachionus, a rotifer restricted to alkaline waters, is favored in Lake Valencia with a pH of about 9.0. Cladocera, scarce in 1968, have declined further. Among copepods, Notodiaptomus venezolanus has been displaced by Thermocyclops hyalinus, now dominant. Cyanophytes dominate phytoplankton throughout the year. Phytoplankton, scarce in 1968, have increased a thousand-fold. Shannon-Wiener diversity index values range 0.84 to 2.09. (Lynch-Wisconsin)
W79-09010

CHLOROPHYLL PIGMENTS IN THE CENTRAL AMAZON LAKES ECOSYSTEM,
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.). Dept. of Tropical Ecology.
H. Rai.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1192-1197.

Descriptors: *Amazon Basin, *Lago Tupe(Brazil), *Lago Janauari(Brazil), *Chlorophyll, *Organic matter, *Water level fluctuations, Ecosystems, Cycling nutrients, Carbon, Particulate organic carbon, Nutrients, Photosynthesis, Seasonal, Euphotic zone, Productivity, Phytoplankton, Algae, Bacteria, Pheo-pigments, Brazil, Distribution, Pigments, Lakes, Detritus, Cycles, Black-water lakes.

The yearly cycle of chlorophyll-a and pheo-pigment distribution in two central Amazon lakes (Brazil), Lago Janauari, a mixed-water lake, and Lago Tupe, a black-water lake, was studied according to relationships among chlorophyll, carbon, bacteria, and nutrients. Results show that rapid recycling of organic matter in the upper photic zone maintains ecological equilibrium in the Amazon aquatic ecosystems. The relationship between bacteria and phytoplankton is complex and varies according to differences in the lake environment, especially in regard to water level fluctuations, an important regulator of microbiological productivity. Chlorophyll-a data must be corrected for pheo-pigments before use as an index of phytoplankton biomass. In Lago Janauari data on chlorophyll and particulate organic carbon (POC) indicate large chlorophyll concentrations do not have correspondingly high carbon values. Low POC:chlorophyll ratios in the lakes during low water implies increased phytoplankton growth accompanied by relatively larger amounts of autochthonous detrital POC. High bacterial densities in Lago Tupe during December, February, and March, and in Lago Janauari in October and December coincide with high chlorophyll-a, but relationships also have been observed between low bacterial densities and high chlorophyll-a, and between high bacterial densities and low chlorophyll-a, conditioned by several factors including phytoplankton composition. (Lynch-Wisconsin)
W79-09011

PRELIMINARY COMPARISON OF THE CRUSTACEAN PLANKTON OF A WHITE WATER AND A BLACK WATER LAKE IN CENTRAL AMAZONIA,
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
G. O. Brandorff.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1198-1202. 3 fig, 1 tab, 5 ref.

Descriptors: *Lago Castanho(Brazil), *Lago Taruma-mirim(Brazil), *Amazon Basin, *Crustaceans, *Zooplankton, *Water level fluctuations, Brazil, Lakes, Faunal lists, Black-water lakes, Bosminidae, Daphnia, Cladocera, Copepods, Hydrogen ion concentration, Species composition, Ria lakes, Secondary productivity.

Comparison of zooplankton data black-water Lago Taruma-Mirim and white-water Lago Castanho in Brazil's Amazonia Province shows that, while planktonic crustaceans in the black-water lake are somewhat smaller and occur in lower numbers than in the white-water lake, differences are not as significant as assumed. Secondary production of the crustacean plankton likewise probably is not as low as often thought. Taruma-mirim is a ria lake with low pH, water darkly colored by humic acids, poor electrolyte content, and almost no macrophytes. Castanho, located in Pleistocene alluvium, has a nearly neutral pH, relatively good nutrient supply, relatively high phytoplankton production, and abundant macrophyte growth. Castanho has 10 cladoceran taxa, three cyclopoid copepods, and five calanoid copepods, while Taruma-mirim has nine cladocerans, one cyclopoid copepod, and seven calanoid copepods. A striking number of Bosminidae taxa are present in Taruma-mirim, including three species of Bosminopsis. More Daphnid taxa were found in Castanho than in Taruma-mirim. Indirect connection of both lakes with the Amazon causes great annual fluctuations in water level averaging 10 m. In Castanho water level correlates inversely with crustacean plankton abundance, while in Taruma-mirim the reverse is true. (Lynch-Wisconsin)
W79-09012

THE HEAT BUDGET OF A LARGE TROPICAL LAKE, LAKE TITICACA (PERU-BOLIVIA),
California Univ., Davis. Div. of Environmental Studies.
T. Kittel, and P. J. Richerson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1203-1209, 3 fig, 1 tab, 17 ref. NSF GA-34099, BMS 75-14273.

Descriptors: *Lake Titicaca(Peru-Bolivia), *Tropical regions, *Heat budgets, *Mixing, *Thermal stratification, *Heat exchange, Peru, Bolivia, Lakes, Circulation, Weather, Meteorological data, Water temperature, Air temperature, Monomixis, Seasonal, Depth, Temperate.

The heat budget of Lake Titicaca (Peru, Bolivia), studied in 1973, provides information on factors controlling mixing and heat exchange in tropical lakes. Reduced seasonality at lower latitudes produces near-equilibrium of heat inputs and outputs, and heat storage consequently results from small fluctuations in net radiation and evaporative heat loss (the main budget terms), and the lake is only weakly stratified. By contrast, in temperate lakes high annual climate oscillation produces strong and relatively regular seasonal changes; most or all show very large storage terms. Epilimnetic temperatures in Lake Titicaca were above median air temperatures for every month in 1973; most low-latitude lakes probably have epilimnion temperatures higher than mean air temperatures all year. Elevated water temperature increases all heat outputs until high radiation inputs are nearly balanced, but only in equable climates since in temperate lakes water temperatures lag behind season to the extent that sensible heat transfer (H) is often a heat input in summer. Most well-studied tropical lakes of intermediate depth have circulation patterns similar to Lake Titicaca's, with only one annual mixing. However, year-to-year variations may have only small effects on circulation. Lake depth is probably more important than altitude in producing departures from the warm monomictic pattern in tropical and equatorial lakes. (Lynch-Wisconsin)
W79-09013

MARITIME ANTARCTIC LAKES,
British Antarctic Survey, Cambridge (England).
R. B. Heywood.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1210-1215. 1 fig, 2 tab, 8 ref.

Descriptors: *Antarctic, *Cold regions, *Signy Island(Antarctica), *Eutrophication, *Vegetation, *Lakes, Amos Lake(Antarctica), Heywood Lake(Antarctica), Sombre Lake(Antarctica), Biocoenoses, Phytoplankton, Algae, Benthic flora, Epiphytes, Nutrients, Seals, Excrement, Chlorophyll, Turbidity, Glacial lakes, Limnology, Limiting factors, Phosphates.

The British Antarctic Survey has shown that Antarctic lakes are unique in that their biocoenoses are simple, and that they lack vascular and emergent plants, insects, mollusks, and vertebrates; these characteristics are largely due to their isolation but also to short, cold summers. However, the biota of Signy Island lakes, the subject of this paper is relatively rich, reflecting proximity of the cold temperate zone of South America. The 17 small glacial lakes and numerous pools present a wide range of physico-chemical regimes. Only plants are described in this study. Winter plant and microbial activity determines success of Antarctic freshwater biocoenoces. In the lakes 139 species of benthic algae have been recognized, including 68 Bacillariophyta, 52 Chlorophyta, 17 Cyanophyta, and two Zanthophyta. Shallow shelf areas, which freeze solid for much of the year, support a simple ephiphytic community on Phormidium sp. felt. Lakes with clear, nutrient-poor waters have well-developed, species-rich, perennial vegetation based on a Tolypothrix sp and Plectonema sp. felt, while turbid, nutrient-rich lakes have sparse, species-poor seasonal vegetation. Phytoplankton, qualitatively and quantitatively poor, comprises 23 species: 11 Chlorophyta, five Chrysophyta, four Cryptophyta, two Bacillariophyta, and one Prasinophyta. Phytoplankton abundance generally is inversely related to that of benthic flora, a function of turbidity rather than competition. Eutrophic Amos Lake, the most affected by seal excrement, has high nutrient levels, poor transparency, poor planktonic flora, and negligible benthic flora. (Lynch-Wisconsin)
W79-09014

AUTOMATIC CONTINUOUS OXYGEN- AND TEMPERATURE-PROFILE MEASUREMENTS,
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
K. Kersting.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977, Vol. 20, September 1978, part 2, p 1216-1220. 4 fig, 2 ref.

Descriptors: *Measurement, *Instrumentation, *Dissolved oxygen, *Water temperature, *Lakes, *Stratification, Research equipment, Winches, Sensors, Monitoring, Depth, Profiles, Methodology, Lake Maarsseveen(Netherlands), Netherlands, Thermistors, Data storage and retrieval, Data collection, Automatic control, Continuous monitoring.

Portable, battery-powered equipment provides automatic and continuous measurement of the diurnal oxygen regime and temperatures in a stratified lake. The system consists of: (1) an automatic winch for lowering and raising the sensors, and (2) a signal conditioning and registration unit. The suspension cable also serves as a power line for the submersible stirrer, essential for accurate oxygen measurements. A 12-volt DC motor drives a cable drum and wormscrew. Sensors include a Y.S.I. 5419 dissolved oxygen probe and a Y.S.I. 401 thermistor. Data are stored on compact magnetic tape cassettes by a Micradata Model 200 data logger made up of two modules: (1) an 8-bit A/D converter, tape deck, 12-channel multiplexer, clock, and power pack; and (2) transducer signal conditioning cards. Seven of these cards are plugged into the Interface Unit: (1) reference card/scan marker; (2) scan counter; (3) potentiometer input card for depth registration; (4) 10 mV full-scale amplifier card for light registration (a LI-COR model LI-192S Quantum sensor with millivolt adaptor is used as the sensor); (5) 150 mV full-scale amplifier card for oxygen registration (the recorder output of a Y.S.I. 54 RC oxygen meter is used as input); (6) thermistor input card measuring temperatures 0-30 C with the thermistor as sensor; and (7) 110 mV full-scale amplifier card for eventual extra measurements of dawn, dusk, and underwater light intensities. The system has been used in the Dutch sandpit lakes Maarsseveen I and II with an error rate of 2-10 per 40,000 8-bit words. (Lynch-Wisconsin)
W79-09015

Group 5C—Effects Of Pollution

ESTIMATION OF THE INORGANIC FRACTION OF TOTAL CARBON IN AQUATIC INVERTEBRATES,
Helsinki Univ., Lammi (Finland). Lammi Biological Station.
K. Salonen, and J. Sarvala.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1221-1225. 1 fig, 1 tab, 9 ref.

Descriptors: *Carbon, *Invertebrates, *Methodology, *Analytical techniques, *Inorganic carbon, *Measurement, Indicators, Biomass, Mollusks, Organic carbon, Total carbon, Ash, Estimating, Ignition, Combustion, Acids, Faunal lists.

Several methods are compared for fractionating total carbon in aquatic invertebrates into organic and inorganic parts. In using total carbon to represent organic carbon as a measure of biomass, the inorganic fraction must be subtracted when, as with shelled invertebrates, the organism contains large quantities of inorganic carbon. Direct methods of determining inorganic carbon include: (1) ignition and analysis of carbon from ash, and (2) acidification and subsequent analysis of evolved carbon dioxide. An indirect method involves determination of calcium, assuming all calcium is present as calcium carbonate. Results show that for animals with less than 10% ash the calcium method overestimates inorganic carbon by several times compared with direct determination by combustion at 950 C and measurement of carbon dioxide. In animals with more than 50% ash practically all calcium can be accounted for by calcium carbonate; for mollusks the two methods agree well since calcium carbonate is a major shell component. The direct method may underestimate inorganic carbon if samples contain bicarbonates or magnesium carbonate, which decomposes at 500 C. In animals with less than 10% ash, inorganic carbon constitutes only 0.003-0.13% of total carbon, and even if all ash is taken to be CaCO3 the value would not exceed 2%. In such cases total carbon is a reasonable measure of organic carbon. (Lynch-Wisconsin)
W79-09016

DETERMINATION OF PHOSPHATASE ACTIVITY IN LAKE WATER--A STUDY OF METHODS,
Uppsala Univ. (Sweden). Inst. of Limnology.
K. Pettersson, and M. Jansson.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1226-1230. 7 tab, 5 ref.

Descriptors: *Methodology, *Measurement, *Phosphatases, *Limiting factors, *Lakes, *Artificial substrates, Fluorometry, E coli, Enzymes, Phytoplankton, Phosphorus, Phosphates, Nutrients, Algae, Water temperature, Hydrogen ion concentration, Alkalinity, Hydrolysis, Assay, 4-methylumbelliferyl phosphate, 3-O-methylfluorescein phosphate, 1-naphtol phosphate, Glycero phosphate, P-nitrophenyl phosphate, Phenolphthalein phosphate.

Assay of the activity of commercial and lake alkaline phosphatases with six substrates shows dependence on type and concentration of substrate, and also on phosphate concentration, temperature, and pH. The most suitable substrate for phosphatase activity measurement in lake water is 4-methylumberlliferyl phosphate (4-MUP). The other fluorgenic substrate, 3-0-methylfluorescein phosphate (3-0-MFP), is also very sensitive (and therefore also has lower incubation time), but problems may occur with competitive inhibition by phosphate. Phosphatase activity is mostly used to detect phosphorus limitation of phytoplankton. Determination is carried out by adding an artificial substrate and then measuring the hydrolysis product. In this study the enzyme affinity of chromogenic and fluorogenic substrates was tested at a field laboratory at Lake Erken, Sweden. Phosphatase from Escherichia coli was purchased, and lake phosphatases were obtained from concentrated net plankton. The other substrates were 1-naphtol phosphate, glycero phosphate, p-nitrophenyl phosphate (p-NPP), and phenolphthalein phosphate. Phenolphthalein-P and glycero-P showed lower affinity to the phosphatases than the other four. In lake waters enzymatic liberation of phosphate is probably limited by the amount of substrates rather than by phosphatase activity, so that the natural hydrolysis rate cannot be estimated from measurements of the latter. (Lynch-Wisconsin)
W79-09017

PROPERTIES OF AN AQUATIC MICRO-ECOSYSTEM: III. DEVELOPMENT OF THE DECOMPOSER SUBSYSTEM AND THE PHOSPHORUS OUTPUT STABILITY,
Amsterdam Univ. (Netherlands). Lab. of Animal Physiology.
K. Bruning, R. Lingeman, and J. Ringelberg.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1231-1235. 3 fig, 7 ref.

Descriptors: *Degradation(Decomposition), *Phosphorus, *Dissolved inorganic phosphorus, *Buffering, *Experimental ecosystems, *Research equipment, Nutrients, Iron, Algae, Autotrophy, Herbivores, Trophic level, Aluminum, Equilibrium, Biological communities, Inorganic compounds, On-site investigations.

The development and steady-state properties of the decomposer subsystem of an experimental microecosystem (M.E.S.) is described, as well as tests of hypotheses regarding the nature of the phosphate buffering mechanism. The M.E.S., consisting of autotrophs (algae), micro-herbivores, and decomposers in separate but connected aquaria, was constructed in spring 1973; this report covers days 180-1067. The subsystem, kept in total darkness, contains a homogeneous layer of water on a bed of sand and gravel. Input water comes from the herbivore unit, and output goes to the autotrophs. Algal biomass fluctuated strongly for about 100 days after day 180. During peak periods dissolved inorganic phosphorus (DIP) concentrations were low in the algal subsystem, and with a small herbivore population, the DIP concentration of decomposer input was almost zero. At low algal levels input as well as output DIP concentrations were high. A less-fluctuating DIP output of the decomposer unit was evident by day 490, followed by a gradual decrease to about day 630, a gradual increase to 105 mu-g P/l on day 770, until these experiments were begun on day 995. The latter demonstrated an evolving mechanism buffering the inorganic phosphorus output of the decomposer unit. Negative DIP production during days 1044-48 following and injection of DIP indicates a true retention mechanism. (Lynch-Wisconsin)
W79-09018

COMPARISON OF SUCCESSIONAL CHANGES IN CHLOROPHYLL LEVELS IN SIMPLE ECOSYSTEMS HAVING DIFFERENT AMOUNTS OF PHOSPHORUS,
Toledo Univ., OH. Dept. of Biology.
P. C. Fraleigh.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1236-1242. 3 fig, 21 ref. AEC AT(38-1)-310.

Descriptors: *Chlorophyll, *Ecosystems, *Experimental ecosystems, *Hot springs, *Phosphorus, *Succession, *Yellowstone National Park(WY), Limiting factors, Nutrients, Ecology, Biological communities, Biomass, Standing crops, Cyanophyta, Light, Indicators, Algae, Phytoplankton, Primary productivity, Wyoming, Regulation, Mastigocladus laminosus, Rotifers, Ostracoda.

Experimental flask ecosystems with different phosphorus content, and two wooden troughs constructed in Yellowstone National Park's Lower Geyser Basin (Wyoming) and receiving water from a hot spring, were used to study environmental regulation of aquatic ecosystem community succession, specifically the effects of nutrient limitation on: (1) succession, (2) changes in chlorophyll-a standing crop, and (3) the ratio of chlorophyll to biomass. Conclusions: (1) during ecological succession the chlorophyll content of the community maximizes in relation to the quantity of a limiting nutrient; (2) at maturity communities maintain maximum standing crops of chlorophyll-a; (3) in flow-through ecosystems there is no direct nutrient control of maximum chlorophyll standing crop, which is determined by biomass and light; and (4) successional changes in the chlorophyll:biomass ratio are an indicator of relative nutrient limitation, decreasing when nutrient limitation is significant and increasing when it is not. The microcosm community, taken from a sewage oxidation pond, consisted of the algae Chlorella sp., Schizothrix calciola, and Scenedesmus sp.; Paramecium sp; the rotifers Lepadella sp. and Philodena sp.; and the ostracod Cypridopsis vidua. Thermal spring water was dominated by the cyanophyte Mastigocladus laminosus, and was piped to the troughs at 30 l/min or 15 l/min. (Lynch-Wisconsin)
W79-09019

PE--A NEW REDOX CONCEPT, ITS APPLICATION AS AN INTENSIVE SELFPURIFICATION PARAMETER,
Freiburg Univ. (Germany, F.R.). Limnologisches Inst.
T. Frevert.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1243-1247. 4 fig, 12 ref.

Descriptors: *pe, *Oxidation-reduction potential, *Self-purification, *Mettma Stream(West Germany), *Streams, *Indicators, *Measurement, Electrons, Electrodes, Methodology, West Germany, Hydrogen ion concentration, Dissolved oxygen, Water chemistry, Wastewater disposal, Breweries, Water pollution effects, Chemical oxygen, Demand, Nitrogen, Ammonium, Nitrites, Nitrates, rH.

A new oxidation-reduction concept, pe, is applied as an intensive self-purification parameter for the mean redox-chemical energy level of polluted water. Based on the Nernstian redox concept, other authors proposed rH and pE to supplement the Nernstian redox potential Eh. To distinguish a constant mixed pE from equilibrium pE, the former is written in lower-case letters. It is proportional to the midpoint potentials and the exchange current densities of the potential-determining redox couples, and is dependent on the nature of the involved redox couples, their electrode kinetics, and the condition of a stationary but not necessarily equilibrium state between them. It is a measurement of electron activity as seen from the electrode. In the field application, pe measurements were made 1976-77 in brewery-wastewater-polluted Mettma Stream in West Germany's Black Forest. The rH/pH technique was used with an inert electrolyte-bridged reference electrode. Parameters analyzed were oxygen, ammonium-nitrogen, nitrite-nitrogen, nitrate-nitrogen, S(II) sub T, COD, and BOD2. Results showed that the wastewater input (COD up to 143 mg equiv/l at Station 1) was eliminated by dilution and biological activity by Station 8, and areas of oxygen deficit varied with respect to COD. Self-purification in the stream can be seen as a successive change in the balance between the rise in electron activity (change in pe) and its elimination by oxidative reactions (pOD). (Lynch-Wisconsin)
W79-09020

PHOTOLYTIC CHANGES IN DISSOLVED HUMIC SUBSTANCES,
Wisconsin Univ.- Madison. Dept. of Botany.
D. J. Strome, and M. C. Miller.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1248-1254. 3 fig, 2 tab, 17 ref.

Descriptors: *Ultraviolet radiation, *Bacteria, *Humus, *Degradation(Decomposition), *Photoly-

sis, *Dissolved solids, *Shortwave radiation, *Longwave radiation, Organic matter, Alaska, Ponds, Barrow(AK), Carbon, Arctic. Cold regions, Light, Soil bacteria, Soils, Particle size, Molecules, Size, Indicators, Cleavage.

Ultraviolet light was much more effective than bacteria in degrading dissolved humic substances in laboratory bottle experiments on soil humics and in field studies in arctic coastal ponds at Barrow, Alaska. There was evidence that cleavage by UV light is an important first step in microbial decomposition of soluble humic substances; bacteria were able to utilize humic photolytic products for growth and were able to reduce humic absorbance to some extent. An unexpected finding, that shortwave/longwave absorbance ratios increase with photolysis and are unaffected by bacteria, may provide a sensitive means of following the process of humic decomposition. It has been proposed that shortwave absorbance represents high-energy charge-transfer reactions in small molecules or loosely polymerized groups, and longwave absorbance represents low-energy excitations in larger, more highly polymerized molecules. This suggests that humic absorbance ratios increase with exposure to UV light because larger molecules are more susceptible to photolysis. Bacteria may cause absorbance ratios to decrease by preferentially attacking smaller molecules. Absorbance ratios may differ greatly for humics from different sources, but within a watershed there are likely to be minimum ratios from humics freshly leached from soil into a water body. Ratios should increase as photolysis proceeds, with a decrease in average molecular size. (Lynch-Wisconsin)
W79-09021

A THEORETICAL EXPRESSION FOR RESUSPENSION APPLIED TO SEDIMENTATION PROCESSES IN LAKES,

Battelle-Pacific Northwest Lab., Richland, WA. Ecosystems Dept.
R. M. Emery.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1255-1258. 1 fig.

Descriptors: *Lakes, *Resuspension, *Sedimentation, *Sediments, *Mathematical models, *Theoretical analysis, Model studies, Extinction, Particulates, Sediment traps, Equations, Sediment transport, Deposition(Sediments).

The magnitude of combined sediment resuspension forces is analyzed theoretically by means of a sediment trap and an extinction model to quantify either the forces of resuspension or the amount of material resuspended. However, the approach is not proposed to explain resuspension mechanics; any force or combination of forces which do not act directly downward are considered responsible for resuspension. A sediment trap is postulated to contain collection regions S and R, the latter covered by a baffle mounted above it. Point A separates the two regions. In the absence of any resuspension forces, all sedimenting particles would be deposited in region S, assuming particle shape permits a truly vertical descent, (the contrary case is also discussed). Resuspension forces would result in particle deposition in region R, with the distance past point A into region R dependent on the strength of the forces. Since region S contains particles which were directly sedimented plus resuspended ones, the concentration of particles in region S (C sub s) serves as a control for evaluating the quantitative extent of lateral displacement into region R. The concentration gradient region R (C sub r) can be expressed by the extinction equation C sub r = C sub s times e to the -kd power (k = extinction coefficient, d = distance from point A). Expressions are given for the magnitude of resuspension and the resuspension coefficient. A sediment trap is suggested for determining the resuspension coefficient k sub r. (Lynch-Wisconsin)
W79-09022

VIRUS-LIKE PARTICLES ISOLATED FROM DIFFERENT POPULATIONS OF AQUATIC GASTROPODS,

Davidson Coll., NC.
W. T. Lammers.
In: Proceedings: 20th Congress, Internatioale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1259-1263. 4 fig, 1 tab, 7 ref.

Descriptors: *Gastropods, *Viruses, *Water pollution effects, *Bioaccumulation, *Streams, *Salt marshes, Spartina, Physa inflata, Melampus bidentatus, Littorinia irrorata, Nesseria obsoletus, Snails, Sapelo Island(GA), Georgia, Rocky River watershed(NC), North Carolina, Rivers, E. coli, Marshes, Optical density, Density, Colloids, Fractionation, Particle size, Centrifugation, Methodology.

Four species of aquatic gastropods were collected from polluted and unpolluted sites in North Carolina and Georgia to study their accumulation of virus-like particles. Three major optical density peaks were found for the freshwater pulmonate snail, Physa inflata, reflecting varying levels of pollution stress in the Rocky River watershed North Carolina. The peaks are: (1) 1.01-1.05 gm/cc, present at all sites but one, and especially well-developed at the most stressed stations; (2) 1.11-1.16 gm/cc, present at all stations, but best developed regarding size and UV fluorescence at the more heavily stressed stations; and (3) 1.2-1.23 gm/cc, obvious only at the three most stressed stations. Little change in density or size of particle peaks was found for the three Spartina salt marsh species between polluted and unpolluted sites on Sapelo Island, Georgia and near Wrightsville Beach, North Carolina. P. inflata is thus a good choice for this type of study, due to its high pollution tolerance and the differences in accumulation of virus-like particles according to changes in the quality and quantity of the particles in the stream. In the salt marsh, the species (Melampus bidentatus, Littorinia irrorata, and Nesseria obsoletus) do not show similar variations in particle accumulation. In the marshes the virus-like particles may flocculate out of suspension as salinity increases. Particle peaks existing in all samples may represent normal tissue viruses, while variable peaks may represent particles accumulated from the water. (Lynch-Wisconsin)
W79-09023

SEPARATION OF ALGAE AND BACTERIA IN LAKE WATER BY SIZE FRACTIONATION,

Lund Univ. (Sweden). Limnological Inst.
M. F. Coveney.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1264-1269. 2 fig, 2 tab, 12 ref.

Descriptors: *Bacteria, *Phytoplankton, *Fractionation, *Particle size, *Filters, *Particle shape, Algae, Size, *Research equipment, Filtration, Membranes, Whatman GF/C filters, Nuclepore filters, Chlorophyll, Cellulose ester membrane filters, Glass fiber filters, Fluorescence, Eutrophication, Lake Bysjon(Sweden), Sweden, Lakes.

The Whatman GF/C glass fiber filter (no defined pore size) is somewhat superior to the three mu-m Nuclepore cellulose ester membrane filter for separating phytoplankton and bacteria in lake water by size fractionation. Surface water samples from eutrophic Lake Bysjon, southern Sweden, were fractionated on seven occasions with the GF/C filter and twice with the Nuclepore filter 1975-76. Bacterial number was verified by direct epifluorescence counting techniques, and algal biomass by microscopic inspection and photometric and fluorometric chlorophyll-a determinations. The two filters are about equally effective in allowing bacteria to pass through, about 70-90% with a volume of 10 ml and 50-60% with 20 ml. The GF/C filter retains almost 100% of total algal biomass, however, compared with 99.4-99.5% for the Nuclepore filter. For small algal cells, the GF/C filter retains all of the 4 x 2 mu-m Phormidium mucicola cells, while the Nuclepore filter retains 89-91%, and the GF/C filter retains 97% of spherical cells of about two mu-m diameter, compared with 44% (10 ml) to 57% (20 ml) with the Nuclepore filter. Retention of algal biomass on the Nuclepore filter is therefore affected by size distribution. It is possible that most of the bacteria not passing through the filters are attached to larger particles, though variations according to volume filtered indicate the influence of other factors, perhaps filtering by seston accumulating on the filter. (Lynch-Wisconsin)
W79-09024

LOSS OF A CRITICAL SPECIES IN A MODEL (LABORATORY) ECOSYSTEM,

Washington Univ., Seattle. Coll. of Fisheries.
F. B. Taub, and M. E. Crow.
In: Proceedings: 20th Congress, International Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1270-1276. 2 fig, 2 tab, 7 ref.

Descriptors: *Experimental ecosystems, *Daphnia magna, *Bioassay, *Toxicity, *Acetone, *Biochemical oxygen demand, *Laboratory tests, Water pollution effects, Research equipment, Cladocera, Algae, Chlamydomonas reinhardti, Biological communities, Poisons, Dissolved oxygen, Ecosystems, Ecology, Protozoa, Tetrahymena vorax, Philodina, Cyridopsis vidua, Rotifers, Bacteria, Serratia marcescens, Nutrients, Phosphates, Nitrates.

The cladoceran Dephnia magna was eliminated from biological communities in 77 of 120 experimental laboratory ecosystems because acetone was used as a solvent for toxicants in bioassays. The presence or absence of Daphnia affects virtually all measurements taken in the microcosms; the loss of one species can have ecosystem-level effects, with both statistical and biological implications. Attempts to statistically analyze data must account for such a divergence among 'replicates' in a study subject to these indirect effects. Biologically, effects on the whole community by loss of one species must be considered. Daphnia processes algal cells into a form more favorable for ostracods and bacteria, resulting in more effective recycling. During bioassays half the microcosms received acetone only and the other half acetone plus toxicants. The Daphnia populations were equally affected by both applications, probably a result of a temporary decrease in oxygen concentration caused by the acetone. In another set of experiments with distilled water as the solvent, Daphnia in only one of 120 microcosms was eliminated. Whereas organic carriers may not be directly toxic to organisms, they may represent an additional organic nutrient to microbes and a BOD stress. Daphnia extinction could probably have been avoided either by inoculating the algal component several days prior to the invertebrates and toxicants, or reinoculation of Daphnia after the acetone addition. (Lynch-Wisconsin)
W79-09025

STUDIES OF THE QUANTITATIVE ESTIMATION OF NATURAL POPULATIONS OF SMALL GREEN ALGAE,

University Coll. of North Wales, Bangor. School of Plant Biology.
C. M. Happey-Wood.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 1277-1284, 3 fig, 5 tab, 12 ref.

Descriptors: *Chlorophyta, *Estimating, *Counting, *Methodology, *Agar plates, *Inverted microscopes, *Testing procedures, Microscopy, Distribution, United Kingdom, Motility, Chlorella pyrenoidosa, Chlamydomonas debaryana, Abundance, Culture media, Size, Ponds, Density, Cultures.

Two methods of counting nonmotile and motile small chlorophytes--(1) the inverted microscope technique, and (2) the agar plate culture technique--gave results which differed significantly

only at extreme population densities. At high densities, greater counts with the inverted microscope are probably due to counting very large numbers of small cells. The agar plate technique is therefore sufficiently accurated for estimation of population densities of small green algae. Problems resulting from heterogeneous distribution of the algae in lake water or on sediments far outweight the slight variability attributable to the plate counting technique, however, and this heterogeneity requires consideration in algal studies. The experiments used Chlorella pyrenoidosa and Chlamydomonas debaryana to compare the two techniques. Variability found among sub-samples in the case of the motile Chlamydomonas suggests a less-even distribution of these algae in the experimental culture than with the nonmotile Chlorella, despite constant shaking between subsampling. No significant movement of motile cells occurs on the agar plates. Significant zoospore release on the plates results in numbers estimated by this method being consistently higher than with the inverted microscope. The least accurate counts were at low population densities of both algae. (Lynch-Wisconsin)
W79-09026

METHODS OF THE REPRESENTATIVE ANALYSIS OF DIATOM COMMUNITIES,
Zaklad Algologii, Lodz (Poland).
J. Z. Kadlubowska.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 1285-1288, 2 tab, 4 ref.

Descriptors: *Diatoms, *Methodology, *Analytical techniques, *Microscopy, *Testing procedures, *Equations, Randomness, Algae, Chrysophyta, Mud, Sampling, Species composition, Abundance, Biological communities, Limnology, Lakes, Rivers.

Methods are described for ensuring that microscopic determinations of diatom community species composition and abundance in water or mud samples are truly representative. The number of fields on a 20 X 20 mm cover glass varies greatly depending on the power of the microscope objective, ranging from 280 at 10X to 20,400 at 90X with a standard microscope. The fields analyzed must be selected at random; the following procedure is recommended: (1) four corners of the cover glass are determined on the longitudinal (horizontal) and transversal (vertical) scales of the microscope cross-table, and designated a, b, c, d; (2) a-b and c-d, each 20,000 mu-m long, are divided into 100 sectors, each 200 mu-m long; and (3) a table is constructed (illustrated) to facilitate random selection, based on the principle that the first number chosen gives the position of a field on the horizontal scale, the second on the vertical scale, etc. A separate table must be prepared for each objective. By this method both the number of taxa per sample and the quantity of diatom cells in a given volume can be calculated. Steps involved: (1) prepare a sample of known volume and dilution, (2) enumerate diatom cells in the random fields, (3) calculate meand cells/field and standard error of the arithmetic mean (equations provided), (4) determine the confidence limit, and (5) calculate average cells/ml water or cu cm mud. An equation is also given for calculating the numerical force of the sample. (Lynch-Wisconsin)
W79-09027

DETERMINATION OF SEASONAL PHYTOPLANKTON COMMUNITIES, BASED ON QUANTITATIVE DATA, USING A MATHEMATICAL ANALYSIS,
Ghent Rijksuniversiteit (Belgium).
A. Caljon.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1289-1292. 3 fig, 12 ref.

Descriptors: *Mathematical studies, *Principal component analysis, *Phytoplankton, *Seasonal, *Analytical techniques, *Species composition, *Population dynamics, Algae, Biological communities, Microscopy, Ditches, Belgium, Standing crops, Ponds, Chlorophyll, Abundance, Water chemistry.

Seasonal phytoplankton communities in a stagnant freshwater pond near Waasmunster, Belgium were determined, using 39 of 162 taxa collected 1972-73. Principal component analysis based on cell number, and the products of cell volume and cell surface with the cell number for each taxon and for each sample, gave results similar to the seasonal analysis for surface and volume values, and slightly different results for cell number. Analysis of physico-chemical data, chlorophyll-a, and standing stock shows a negative correlation. There is a very strong correlation between total cell surface and total cell volume as measures of total dynamics of the 39 taxa, but both indicators show less satisfactory agreement with phytoplankton dynamics phytoplankton expressed as total cell number. Spring community: Diatoma elongatum, D. elongatum var. actinastroides, Euglena proxima, Peridinium palatinum, Dinobryon sertularia, Synedra acus var. radians, Chodatella quadriseta, Merismopedia glauca, Trachelomonas hispida var. crenulatocollis, Chrysococcus minutus, Kephyrion asper, Cyclotella comta, Scenedesmus quadricauda, Bicoeca planctonica, Nephrocytium agardhianum, and Crucigenia quadrata. Summer: Peridinium lomnickii, P. polonicum, P. elpatiewskyi, Cryptomonas erosa, C. ovata, Aphanizomenon flos-aquae, Trachelomonas volvocina, Anabaena planctonica, Gymnodinium rotundatum, Microcystis marginata, and Coelastrum microporum. Autumn: Ceratium hirundinella, Cryptomonas marssonii, C. vurvata, and Oocystis lacustris. Winter: Closterium gracile and Peridinium aciculiferum. (Lynch-Wisconsin)
W79-09028

AN EXPERIMENTAL THREE-STEP BENTHIC FOOD CHAIN,
Zoologisches Inst., Basel (Switzerland).
B. Streit.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1293-1297. 2 fig, 6 ref.

Descriptors: *Testing procedures, *Food chains, *Benthos, *Methodology, *Bioaccumulation, *Carbon cycle, Algae, Limpets, Gastropods, Benthic fauna, Benthic flora, Invertebrates, Leeches, Periphyton, Nitzschia actinastroides, Chrysophyta, Diatoms, Ancylus fluviatilis, Glossiphonia complanata, Pesticides, Tracers, Carbon radioisotopes, Grazing, Predation, Filters, Carbon, Hirudinea, Energy.

A laboratory benthic food chain consisting of a primary consumer, the limpet Ancylus fluviatilis feeding on the periphytic diatom Nitzschia actinastroides, and a secondary consumer, the leech Glossiphonia complanata feeding on the limpet, simulates natural conditions and is suitable for measuring carbon balances and pesticide bioaccumulation. Nitzschia, cultivated in chemostatic or batch cultures, may be used directly or after labelling with Na H14CO3 (uniform labelling) or with carbon-14 labelled pesticides. Biomass per unit volume is determined by measuring light extinction of the suspension at 720 m in a photometer. A defined volume of the suspension is filtered into a cellulose nitrate millipore filter (47 mm diam), washed with tap water, and transferred into an Erlenmeyer flask containing about 100 ml tap water. Algae stop growing and remain firmly attached to the filter. This method does not work with the chlorophyte Scenedesmus or the cyanophyte Anabaena. It is thus possible to offer various concentrations of carbon per surface unit to the snails up to about two mg C/ sq mm. Algae on the filter may be used 3-4 days, then a new filter must be prepared. Oxygen content and pH will not change significantly if the vessel is aerated. Limpet excretions may cause ammonium content to rise. Leeches are added as a third step. Carbon balances are determined by measuring algae planimetrically, animal weight, feces, and egg capsules. (Lynch-Wisconsin)
W79-09029

ANNUAL SEASONAL VARIATION OF PHYTOPLANKTON PRIMARY PRODUCTIVITY AND BIOMASS, CORRELATED WITH PHYSICAL PARAMETERS IN THE OTTAWA RIVER, CANADA,
Queen's Univ., Kingston (Ontario). Dept. of Biology.
A. S. Rosemarin, and J. S. Hart.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1299-1306. 2 fig, 19 ref.

Descriptors: *Seasonal, *Phytoplankton, *Biomass, *Primary productivity, *Water temperature, *Ottawa River(Canada), Rivers, Algae, Physical properties, Canada, Light, Transparency, High flow, River flow, Regression analysis, Discharge(Water), Pulp and paper industry, Municipal wastes, Industrial wastes.

Water temperature, followed by incident radiant energy, are the most important factors determining seasonal variation in phytoplankton primary productivity and biomass in the Ottawa River, Canada, based on regression analysis of 1971-72 data. Primary productivity variation is influenced by phytoplankton biomass variation only after effects of temperature and incident radiant energy are reduced in such calculations. Spring river discharge positively correlates with and is the major negative factor controlling phytoplankton productivity and biomass levels. Low Secchi disk transparency is associated with high river discharge. The 1330-km Ottawa River, which drains an area of 145,000 sq km in eastern Ontario and western Quebec, has mean annual flow of over 1980 cu m/sec near its mouth. The water is soft, low to intermediate in total alkalinity, has a pH of 7.1-7.2, and is brownish due to humic acids. Sampling was carried out near the city of Ottawa 6.5 km downstream from a sulfite paper mill. Phytoplankton productivity ranges from 0.5 mg/C/sq m/day under ice cover to 406 mg/sq m in June, with an integrated annual mean of 57 mg/sq m. A secondary peak occurred in the fall. Fresh-weight biomass ranges from 0.5 mu-g/l in February to 51 mu-g/l in August, with algal cell numbers varying from almost zero in March to 90,000 in late October. Peaks in biomass and cell number occur in fall and summer. (Lynch-Wisconsin)
W79-09030

VARIATIONS IN THE PRODUCTION OF EMERGING INSECTS FROM A QUEBEC STREAM,
Montreal Univ. (Quebec). Dept. of Biological Sciences.
P. P. Harper.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1347-1323. 5 fig, 2 tab, 9 ref.

Descriptors: *Insects, *Emerging insects, *Streams, *Benthic fauna, *Productivity, Quebec(Canada), Canada, L'Achigan River Basin(Quebec-Canada), Rivers basins, Tributaries, Food webs, Growth stages, Invertebrates, Secondary productivity, Carnivores, Riffles, Filter feeders, Diptera, Odonata, Ephemeroptera, Plecoptera, Chironomidae, Tricoptera, Tanytarsini, Simuliidae, Habitats, Baseline studies.

Production of insects emerging from a second-order stream in the l'Achigan River system, Quebec, Canada, was studied from the May thaw to autumn in 1972 and 1973 to supplement existing data on benthic production, which is usually limited to that passing directly into the aquatic food web. The 500-m stream contains three shallow riffle areas and two deeper pools, and is 1-5 m wide. Discharge varies 80-1000 l/sec, with a maximum velocity of 100 cm/sec. Some 257,771 insects were collected with pyramidal emergence traps, identified for species except the chiromid groups Orthocladiinae and Tanytarsini, and dry wt estimated. The 17 stations produce 9,118-48,300 indiv/sq m/yr, with upstream sections of riffles the most productive due to a prevalence of filter feeders,

pools the least productive, and lower riffle areas intermediate. The highest weight recorded was 15.37 g/sq m (Station 5), higher than reported for any previous studies; high production is inversely related to percentage of carnivores. Diptera dominate in all habitats except two stations dominated by Plecoptera and one each by Ephemeroptera and Odonata. High Diptera levels at Stations 3-5 are due to emergence of blackflies (Simuliidae), and at Station 14 by Tanytarsini. A total of 243 species have been identified so far including 119 Diptera, 60 Trichoptera, 24 each of Ephemeroptera and Plecoptera, and 11 Odonata. Higher weights were recorded in 1973 than 1972, presumably related to much lower discharges in 1973. (Lynch-Wisconsin)
W79-09031

PATTERNS OF NITROGEN UPTAKE AND LOSS IN RELATION TO LITTER DISAPPEARANCE AND ASSOCIATED INVERTEBRATE BIOMASS IN SIX STREAMS OF THE PACIFIC NORTHWEST, U.S.A.,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
F. J. Triska, and B. M. Buckley.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1324-1332. 5 fig, 2 tab, 20 ref.

Descriptors: *Nitrogen, *Litter, *Needles, *Invertebrates, *Degradation(Decomposition), *Streams, *Absorption, Biomass, Washington, Oregon, Mountains, Pacific Northwest U.S., Leaves, Microorganisms, Ecosystems, Ecology, Carbon, Productivity, Decay coefficient, Limiting factors, Leaching, Nutrients, Flynn Creek(OR), Needle Branch Creek(OR), Mack Creek(OR), WS 10(OR, Experimental Spring(WA).

Study of needle leaf litter processing in six streams in Oregon and Washington shows that the capacity of litter microflora to mediate nitrogen uptake and release may directly influence production of litter-consuming invertebrates in lotic ecosystems. Previous studies in streams of the area indicate that if any nutrient limits biota associated with litter, it is nitrogen. Despite a five-fold variation in the decay coefficient among the streams, a qualitatively similar pattern of nitrogen uptake and release was observed, characterized by large leaching loss followed by nitrogen gain presumably related to microbial colonization. All streams gain nitrogen sometime during decomposition, resulting in a nitrogen sink for the ecosystem, and a source of nitrogen to litter-consuming invertebrates. Highest invertebrate biomass is associated with packs of needle litter when the carbon-nitrogen ratio is lowest, notably in Needle Branch Creek where the lowest C/N ratio is observed. Four of the streams are located in two Oregon mountain areas, the Coast Range (Flynn Creek and Needle Branch Creek) and Cascade Range (Mack Creek and WS 10). The other two streams, man-made, are fed by a large spring at the Experimental Spring site in southwest Washington. Needle litter was dried at 50 C, strung on nylon line to form 5-15 g packs, and anchored in streams with bricks. Stream habitats ranged from completely exposed to densely canopied. (Lynch-Wisconsin)
W79-09032

PRESENCE AND ECOLOGICAL ROLE OF NITROGEN-FIXING BACTERIA ASSOCIATED WITH WOOD DECAY IN STREAMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
B. M. Buckley, and F. J. Triska.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1333-1339. 2 fig, 3 tab, 20 ref. NSF DEB-74-20744A02.

Descriptors: *Degradation(Decomposition), *Wood, *Streams, *Nitrogen fixing bacteria, *Nitrogen fixation, WS 2(OR), Oregon, Cascade Mountains(OR), Forest watersheds, Litter, Trees, Douglas fir trees, Acetylene reduction, Mountain forests, Enzymes, Nitrogenases, Enterobacter agglomerans, Pseudotsuga menziesii, Substrates, Ecology, Bacteria, Bark, Pacific Northwest U.S.

The potential role of nitrogen fixation on old-growth wood debris was investigated in a second-order stream, Watershed 2 (WS 2), in the H.J. Andrews Experimental Forest in Oregon's Cascade Mountains. Results show that nitrogen fixation may play an important role both in decomposition of wood in lotic systems and in the nitrogen economy of Pacific Northwest old-growth forest streams. The forest is dominated by virgin stands of Douglas fir (Pseudotsuga menziesii), which contribute large amounts of wood to the terrestrial and aquatic environments. Four substrates were tested March 1975-May 1976 with acetylene reduction: twigs, bark, chips, and blocks. Substrates were dried at 50 C, weighed, placed into nylon mesh litter bags, incubated in the stream, and removed seasonally. Some nitrogenase activity was observed in all four types, with highest rates of acetylene reduction associated with twigs and chips, probably due to higher surface-to-volume ratios. Denser blocks and bark showed lowest rates. Reduction rates were generally highest during warmest months (April-September). Major seasonal differences are attributed to temperature, as the nitrogenase enzyme system is inhibited by colder temperatures (especially below five C). H-tube isolations in dilution series generally confirm field data. Isolates from field samples in selective media likewise confirm the presence of nitrogen-fixing organisms, including Enterobacter agglomerans, a terrestrial nitrogen-fixing bacterium on wood. (Lynch-Wisconsin)
W79-09033

PHOSPHORUS DYNAMICS ON ORGANIC AND INORGANIC SUBSTRATES IN STREAMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
S. V. Gregory.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1340-1346. 4 fig, 2 tab, 6 ref. NSF DEB-74-20744A02.

Descriptors: *Phosphorus, *Streams, *Leaves, *Substrates, *Absorption, *Biological communities, Benthic flora, Dynamics, Nutrients, Needles, Sediments, Retention time, Algae, Berry Creek(OR), Mack Creek(OR), Epilithic, Periphyton, Aquatic plants, Detritus, Prasiola, Petasites frigidus, Chlorophyta, Zygnema, Maple trees, Alder trees, Oregon, Cascade Mountains(OR), Litter, Forest watersheds, Pacific Northwest US.

Physical and biological processes of phosphorus sorption onto organic and inorganic stream substrates were investigated with rocks and leaf bags in various streams in the H.J. Andrews Experimental Forest in the Cascade Mountains of Oregon. Data indicate sorption of phosphorus onto substrates is predominately a biological process regulated by the quantity of benthic algae, bacteria, and fungi. Volcanic rock samples, conifer needles, and bigleaf maple and alder leaves were used in the tests, and orthophosphate absorption by the primary producers Zygnema sp (a filamentous green alga), Prasiola sp. (a monostromatic sheetlike green alga), and Petasites frigidus (a herbaceous plant) was monitored. Physical sorption was generally less than 20% of phosphorus translocation onto benthic substrates. Major physical factors affecting phosphorus uptake are those enhancing retention time of stream water, including gradient, debris dams, and channel roughness. Higher retention time augments the time available for the biota to remove phosphorus in solution. Detritus quality is important in determining phosphorus uptake potential; more refractory organic matter such as conifer needles or highly lignified, fine organic matter cannot support as much microbial metabolism as more labile materials such as alder or maple leaves. Phosphorus uptake increases with the length of time the leaf material has been in the stream. Thin-layered epilithic algal communities had highest phosphorus absorption rates among autotrophs. (Lynch-Wisconsin)
W79-09034

ECOLOGICAL EFFECTS OF FOREST FERTILIZATION WITH UREA ON SMALL WESTERN CASCADE STREAMS OF OREGON, U.S.A.,
Corvallis Environmental Research, Lab., OR.
F. S. Stay, K. W. Malueg, R. E. Austin, M. R. Crouse, and A. Katko.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1347-1358. 8 fig, 2 tab, 15 ref.

Descriptors: *Urea, *Fertilization, *Streams, *Environmental effects, *Water pollution effects, *Nitrogen, Ecology, Invertebrates, Fish, Rainbow trout, Salmo gairdneri, Nitrates, Nitrites, Ammonia, Algae, Algal growth potential, Limiting factors, Buffering, Nutrient loading, Bioassay, Water chemistry, Cascade Mountains(OR), Oregon, Forest watersheds, Mountain forests, Pacific Northwest US, On-site investigations.

Urea fertilization of a 1926-ha stand of second-growth Douglas fir in Oregon's Cascade Mountains in April 1976 did not significantly affect organisms in area streams during a study conducted March-December 1976. Unfertilized buffer strips 30-45 m wide were maintained on both sides of five creeks, and two creeks in unfertilized areas served as controls. Urea was applied by broadcasting agricultural-grade prills 1-2 mm in diameter from a helicopter at about 225 kg N/ha. Conclusions: (1) violation of buffer strips temporarily elevated nitrogen levels in streams immediately following fertilization, (2) high nitrogen concentrations in Seventh Creek were probably due to fertilization of its unbuffered headwater streams, (3) the width of the buffer strips (30 vs 45 m) did not affect nitrogen loading to streams, (4) algal assays showed no significant change in algal growth potential, (5) no changes observed in macroinvertebrate populations of the streams could be conclusively attributed to fertilization, and (6) fish assays with rainbow trout (salmo gairdneri) showed no mortalities due to fertilization. Drift net macroinvertebrate samples showed a peak in abundance (particularly dipterans and ephemeropterans) at the beginning of fertilization, but during the later period of most intense fertilization no such peak was observed. Diversity index values occasionally indicated perturbation, but such episodes occurred both before and after fertilization. (Lynch-Wisconsin)
W79-09035

AN IMPROVED DESIGN FOR ASSESSING IMPACTS OF WATERSHED PRACTICES ON SMALL STREAMS,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
J. D. Hall, M. L. Murphy, and R. S. Aho.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1359-1365. 1 fig, 2 tab, 15 ref. NSF DEB-74-20744A02.

Descriptors: *Methodology, *Environmental effects, *Watershed management, *Lumbering, *Streams, *Fish, *Analytical techniques, Land use, Evaluation, Watersheds(Basins), Forest watersheds, Ecosystems, Salmanders, Coho salmon, Oncorhynchus kisutch, Cutthroat trout, Salmo clarki, Dicamptodon ensatus, Pacific giant salamander, Mountain forests, Oregon, Cascade Mountains(OR), Statistical methods.

Comparative evaluation of four approaches for assessing effects of watershed management practices (such as logging and grazing) on stream ecosystems indicates that extensive post-treatment analysis with paired-site comparisons provides the most useful information. Other approaches: (1) conventional long-term, or intensive before-after, study; (2) extensive before-after comparison; and (3) intensive post-treatment analysis. All four methods have been used in Oregon in recent years to evaluate effects of logging on coho salmon (Oncorhynchus kisutch), cutthroat trout (Salmo clarki), and the Pacific giant salamander (Dicamptodon ensatus). The extensive post-treatment approach, by studying a wide array of watersheds

treated in different ways or at different times in the past, permits assessment of either or both serverity of effects of various treatments and length of time an effect may persist. Use of paired-site comparisons often reduces variance and significantly increases precision. Pairing is most applicable in cases of localized impacts, however, and may not be as effective where general effects over whole watersheds are involved. In such cases a combined extensive-intensive approach with paired-site comparisons in both is recommended. A disadvantage of the technique is relatively high cost concentrated in a short period (2-3 years). Results of long-term studies are difficult to evaluate because of natural variations. Generalized nonparametric tests should replace parametric ones since the very small sample size of most watershed studies casts serious doubt on the assumption of normality. (Lynch-Wisconsin)
W79-09036

TRANSPORT OF PARTICULATE ORGANIC MATERIAL IN STREAMS AS A FUNCTION OF PHYSICAL PROCESSES,
Oregon State Univ., Corvallis. Dept. of Fisheries and Wildlife.
J. R. Sedell, R. J. Naiman, K. W. Cummins, G. W. Minshall, and R. L. Vannote.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1366-1375. 3 fig, 2 tab, 15 ref. NSF BMS-75-0733.

Descriptors: *Sediment transport, *Particulate organic matter, *Streams, *Stream power, *Rivers, *Particle size, Organic matter, Very fine particulate organic matter, Oregon, Idaho, Michigan, Pennsylvania, Detritus, Watersheds(Basins), River basins, Channel morphology, Streambeds, Streamflow, Gradients(Streams), Physical properties, Indicators.

Examination of particulate organic matter (POM) transport in 16 streams and rivers of different sizes located (four each) in Oregon, Idaho, Michigan, and Pennsylvania shows: (1) very fine particulate organic matter (VPOM) dominate POM transport in all streams sizes in all regions during all seasons, and (2) unit stream power is a theoretically sound physical variable against which to study particulate transport. Stream power includes concepts of water density, rate of discharge, and stream gradient. Since organic particulates do not behave like inorganic sediments due to lower specific gravity and higher surface-to-volume ratios, further scaling of unit stream power with retention indices (the ability of the system to store POM) would provide a better index of POM transport. The highest POM levels and largest concentration ranges are in Michigan streams, with mean concentrations ranging from 4757 mg/cu m in the Kalamazoo River to 7126 mg/cu m in upper Augusta Creek. Idaho streams show greatest annual variation in concentration, and Oregon streams transport the least POM (almost an order of magnitude below the other regions) and have narrow annual ranges. Exported POM have a mean diameter of 5-12 mu-m in all streams, though type and amounts of organic inputs vary greatly. Most transport is in the VPOM range; therefore, gradient, unit stream power, and watershed area are particularly important since VPOM is easily suspended and is less influenced by streambed roughness or stream retention characteristics. (Lynch-Wisconsin)
W79-09037

DIVERSITY IN STREAM INSECTS: REGULATION BY ROCK SIZE AND MICROSPATIAL COMPLEXITY,
California Univ., Davis. Div. of Environmental Studies.
D. D. Hart.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1376-1381. 2 fig, 4 tab, 18 ref.

Descriptors: *Rocks, *Size, *Shape, *Species diversity, *Species richness, *Insects, Habitats, Substrates, Regulation, Colonization, Sagehen Creek(CA), California, Ephemeroptera, Plecoptera, Tricoptera, Coleoptera, Diversity indices.

Rock size and complexity of shape correlate positively with insect species richness and Shannon-Wiener diversity in an experiment conducted in Sagehen Creek, Sierra County, California. Simulated rocks were made of fired ceramic clay in three shapes, each of two sizes. Twelve replicate sets were each fastened to a 20 x 45 cm board in a consistent pattern, placed in the stream at depths of 25-40 cm at a site containing rocks similar to the replicas, and retrieved after 35 days. Current velocity ranged from 20-40 cm/sec. The six rock types are: (1) large sphere (about 710 sq cm surface area), (2) small sphere (105 sq cm), (3) large cube (547 sq cm), (4) small cube (89 sq cm), (5) large irregular cube (550 sq cm), and (6) small irregular cube (92 sq cm). Only Ephemeroptera, Trichoptera, Plecoptera, and Coleoptera were counted for the study. Within shapes, large rocks hold more species than small, and within sizes, the number of species is greatest on the irregular cubes, intermediate on the cubes, and lowest on the spheres. Equalization of variances show significant differences in mean richness due to both size (p .001) and shape (p .05). Duncan's multiple range test on untransformed data gives similar results, but show indistinguishable means among the three smaller rocks. While richness/area is significantly higher on irregular than spherical rocks, large rocks have significantly less species/area than small. Species richness/rock correlate positively with number of individuals/rock. Increased richness on complex rocks is due to greater resource diversity. (Lynch-Wisconsin)
W79-09038

MACROINVERTEBRATE COMMUNITY STRUCTURE OF FOUR SPECIAL LOTIC HABITATS IN COLORADO, U.S.A.,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
J. V. Ward, and R. A. Short.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1382-1387. 2 tab, 14 ref.

Descriptors: *Insects, *Biological communities, *Bioindicators, *Colorado, *Streams, *Impoundments, Rivers, Regulation, Dams, Environmental effects, Joe Wright Creek(CO), South Platte River(CO), Trout Creek(CO), North Fork(CO), Reservoirs, Irrigation, Epilithic, Rooted aquatic plants, Species diversity, Invertebrates, Ephemeroptera, Trichoptera, Plecoptera, Diptera, Baetis, Brachycentrus, Amphipoda, Alloperla, Ecology.

Macroinvertebrate communities of four dammed Colorado streams were compared to identify taxa useful as indicators of effects of stream regulation. Unregulated portions of the streams served as experiment controls. Stream sites included: (1) Joe Wright Creek below an irrigation reservoir, exhibiting great discharge fluctuations; (2) a spring brook site north of Horsetooth Reservoir, which lacks an upstream source of limnetic seston but has constant conditions similar to some sites below dams; (3) Trout Creek below a surface-release reservoir; and (4) the South Platte River below a deep-release reservoir (Cheesman Lake), which moderates major flow fluctuations. No sites were disturbed except by dams; fauna consist primarily of insects (except in the spring brook), especially Ephemeroptera, Plecoptera, Diptera, and Tricoptera. Most of the fauna can be classified in four groups; (1) euryokous, or tolerant, organisms found in virtually all regulated or unregulated streams, but which may become abundant with certain types of regulation, such as the mayfly Baetis in the South Platte, the spring brook, and Joe Wright Creek; (2) organisms present in unregulated streams and favored by certain types of regulation, such as the stonefly Alloperla in Joe Wright Creek; (3) intolerant organisms present in unregulated streams but reduced or absent in regulated streams, such as the trichopteran Brachycentrus; and (4) organisms not normally present in unregulated mountain streams, but characteristic of regulated streams, such as amphipods in Trout Creek, the South Platte, and the spring brook. (Lynch-Wisconsin)
W79-09039

ENERGETIC EVALUATION OF A STREAM ECOSYSTEM AFFECTED BY COAL MINE DRAINAGE,
Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering.
W. J. Mitsch, M. A. McPartlin, and R. D. Letterman.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1388-1395. 2 fig, 4 tab, 32 ref.

Descriptors: *Energy, *Mine drainage, *Ben's Creek(PA), *Trophic level, *Fish, *Invertebrates, *Water pollution effects, *Analytical techniques, Coal mines, Streams, Pennsylvania, Benthic fauna, Insects, Sculpin, Cottus bairdi, Brown trout, Salmos trutta, Biological communities, Mortality, Food habits, Biomass, Ecosystems, Energy quality.

Energetics is assessed with a simplified methodology in Ben's Creek, a small fourth-order stream in western Pennsylvania near Johnstown polluted by acid drainage from an abandoned coal mine. The trophic level and energy quality approaches are employed; the latter, which gives higher energetic value to organisms at higher trophic levels, includes important concepts for evaluating stream energetics. Benthic macroinvertebrates and fish dominate consumers; terrestrial insects, detritus, and primary producers round out the energy flow diagram. Sculpin (Cottus bairdi) and brown trout (Salmo trutta) are particularly important fish. The stream is dependent primarily on allochthonous organic matter, but primary producers are included as forcing functions. Sampling during summer 1976 showed invertebrate biomass declined 87% downstream of the mine drainage compared with the upstream value, and fish biomass declined 95%. Total productivity upstream is estimated at 573 cal/sq m/day for invertebrates and 1020 cal/sq m/day for fish. The imbalance may be due to sampling inefficiency, high insect emergence in summer, and fish migration upstream. Energy quality calculations assume detritus to have an energy quality factor of 1.0. Values increase with increasing trophic level. The higher quality animals seem to suffer a higher mortality rate as a result of the mine drainage; stress reduces diversity by removing the stabilizing representatives of higher trophic levels. (Lynch-Wisconsin)
W79-09040

ROLE OF DETRIVORE SELECTIVITY IN SPECIES-SPECIFIC LITTER DECOMPOSITION IN A WOODLAND STREAM,
North Carolina Univ. at Chapel Hill. Dept. of Zoology.
S. R. Reice.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1396-1400. 2 fig, 2 tab, 10 ref. NSF bms 74-15332.

Descriptors: *New Hope Creek(NC), *Leaves, *Insects, *Degradation(Decomposition), *Detritus, *Selectivity, Specialization, Food habits, Streams, North Carolina, Detritovores, Litter, Biomass, Ecosystems, Biological communities, Forest watersheds, Trees, Chironomidae, Oligochaetes, Hydracarina, Carya tomentosa, Cornus florida, Fagus grandifolia, Fraxinus americana, Liquidambar styraciflua, Liriodendron tulipifera, Oxydendrum arboreum, Platanus occidentalis, Quercus alba, Quercus rubra, Acer rubrum.

Although there is no overall specialization pattern of detritivorous insects according to leaf decomposition rates in New Hope Creek, North Carolina, insect taxa do specialize individually. These specialists counterbalance one another, resulting in the artificially uniform overall pattern. Leaf packs of 11 local species of deciduous trees were attached to bricks and placed in a stream riffle 2 June 1975.

Triplicate sets were removed on June 3, 4, 9, 16, 23, and 30, leaf packs were weighed, and chironomid larvae, oligochaetes, and Hydracarina were counted. Leaves were classified as to decomposition rate: (1) fast (78-100% biomass loss in 28 days)--Cornus florida (flowering dogwood), Oxydendrum arboreum (sourwood), Fraxinus americana (white ash), and Liriodendron tulipifera (yellow poplar); (2) moderate (66-72% loss)--Liquidambar styraciflua (sweetgum), Acer (red maple), and Carya tomentosa (mockernut hickory); and (3) slow (38-53% loss)--Quercus alba (white oak), Q. ruba (northern red oak), Platanus occidentalis (American sycamore), and Fagus grandifolia (American beech). Insect taxa differing from the overall uniform distribution are: (1) Overabundance on slow leaves--Isonychia similus, Stenonema annexum, S. rubrum (Ephemeroptera); Cheumatopsyche sp., Hydropsyche sp. (Trichoptera); and Acroneuria abnormis (Plecoptera). (2) Overabundance on fast leaves--Simuliidae, Hydracarina. (3) Underabundance on slow leaves--Chironomidae. (4) Underabundance on fast leaves--Oligochaeta. Results also suggest that the direct role of macrodecomposers is relatively minor compared to the role of microbes. (Lynch-Wisconsin)
W79-09041

TRACE METAL TRANSPORT BY PARTICULATES AND ORGANIC CARBON IN TWO SOUTH CAROLINA STREAMS,
Savannah River Ecology Lab., Aiken, SC.
J. P. Giesy, Jr., and L. A. Briese.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1401-1417. 6 fig, 4 tab, 52 ref. ERDA EY-76-C-09-0819.

Descriptors: *Steel Creek(SC), *Upper Three Runs Creek(SC), *Trace elements, *Metals, *Path of pollutants, *Sediment transport, South Carolina, Organic carbon, Suspended solids, Streams, Heavy metals, Carbon, Hydrogen ion concentration, Soft water, Humics, Copper, Cadmium, Chromium, Zinc, Iron, Calcium, Magnesium, Manganese, Cobalt, Lead, Nickel.

A study was conducted of: (1) spatial and temporal variations of concentrations of 11 elements associated with six suspended and dissolved size fractions in two South Carolina coastal plain streams, and (2) relative importance of various fractions in trace metal transport. Study locations were Upper Three Runs Creek, an acid softwater stream, and Steel Creek, also softwater, but with higher pH, alkalinity and suspended solids, and less-colored water from organic carbon (OC). Elements monitored were calcium, cobalt, copper, cadmium, chromium, iron, magnesium, manganese, nickel, lead, and zinc. Conclusions: (1) the suspended solids load is much higher in Steel Creek, while in Upper Three Runs a higher proportion of suspended solids is organic; (2) most dissolved organic carbon in both streams have low molecular weight (<500); (3) lead is always more highly associated with larger organics, and in Steel Creek is transported mostly in suspended solids and in Upper Three Runs in the fraction with molecular weight 500; (6) most calcium is transported in the fraction with molecular weight 500, and is associated with all molecular weight organic fractions with similar Ca:OC ratios; (7) iron is transported in the suspended solids fraction in both streams, but up to 50% is transported in the 500 molecular weight fraction in Upper Three Runs in July; (8) Cu, Cd, Cr, and Zn are not highly associated with suspended solids, and are transported as free divalent ions or associated with organics; and (9) most Ni and Mn are in the smallest pore size ultrafilter fraction. (Lynch-Wisconsin)
W79-09042

BEHAVIOR AND BUDGETS OF SELECTED IONS IN THE WYE CATCHMENT,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
R. W. Edwards, A. C. Oborne, M. P. Brooker, and H. T. Sambrook.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1418-1422. 4 fig, 1 tab, 7 ref.

Descriptors: *Wye River Basin(Wales), *Nutrient budgets, *Calcium, *Silicon, *Nitrates, *Streamflow, Wales, River basins, Ions, Nutrients, Nitrogen, Silica, Diatoms, Algae, Chrysophyta, Water chemistry, Geology, Mollusks, Crustaceans, Invertebrates, Seasonal, Chlorophyll, Sphaerium corneum, Gammarus pulex, Asellus aquaticus, Rivers.

Water samples were taken from the River Wye's predominately rural catchment, Wales, at 15 sites 1975-76, and at one site from 1973 onwards, to study behavior and budgets of calcium, silicon (as reactive silica), and nitrate-nitrogen. Mean calcium increases from one mg/l in the upper basin to 32 mg/l downstream as a result of changing geology. Several invertebrates, including Sphaerium corneum, Gammarus pulex, and Asellus aquaticus, are restricted to sites with calcium levels above 10 mg/l. At all gauged sites except one calcium concentrations are related inversely to flow. Silica at one downstream site shows high winter concentrations (six mg SiO2/l) and low spring-summer ones (<0.5 mg/l). At the same site silicon and chlorophyll-a are correlated inversely with silicon depletion partly a result of diatom production. During April-July in the headwaters silicon concentration and flow are related inversely, whereas downstream the situation is reversed, probably reflecting diatom uptake of silicon in spring and summer during lower flows, which provide maximum retention time and opportunity for contact with benthos. At high flow maxima silica levels increase from three/mg/l upstream to seven mg/l downstream. Annual depletion within the river is about 3000 metric tons SiO2. Maximum nitrate values occur in winter (five mg/l) and minimum values in summer (0.13 mg/l) at a downstream site. May-December measured loads (10.6 kg/yr) are lower than calculated loads (12.7 kg/yr). Sewage accounts for 12% of calculated load. (Lynch-Wisconsin)
W79-09043

MEASUREMENT OF SULPHATE UPTAKE IN THE DARK BY SUSPENDED MICRO-ORGANISMS: APPLICATION TO RUNNING WATERS,
Quebec Univ., Montreal.
P. G. C. Campbell, and J. H. Baker.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1423-1428. 1 fig, 2 tab, 24 ref.

Descriptors: *River Frome(England), *Dark sulfate uptake, *Sulfates, *Analytical techniques, *Phytoplankton, *Diatoms, *Bacteria, Heterotrophy, Navicula pelliculosa, Melosira varians, Diatoma vulgare, Chrysophyta, Sulfur, Methodology, Eutrophication, Algae, Size, Fractionation, Seasonal, Darkness, Chlorophyll, Absorption, Seston, Glucose, Rivers, England.

Demonstration of dark sulfate uptake by the diatom Navicula pellicosa (70-72 ng S/l/hr, or 70% of the 104 ng uptake in the light) shows that sestonic diatoms contribute significantly to dark uptake of sulfate by suspended microorganisms in the River, southern England. Should dark sulfate uptake by phytoplankton prove generally true, the dark sulfate method of measuring planktonic heterotrophy would be seriously compromised. The River Frome is a relatively unpolluted, nutrient-rich chalk stream. Heterotrophic activity of suspended bacteria in the river was studied by measurement of dark sulfate uptake coupled with glucose incorporation measurements, a method which assumes that dark sulfate uptake by suspended algae is negligible, the concentration of reduced organic sulfur in the water is low (< 40 mu-g s-org/l), and the ratio of DOC uptake to sulfate uptake for bacteria is reasonably constant. Water samples were collected January-June 1977. Dark sulfate uptake is very low (five ng S/l/hr) until the end of March, but increases to 60 ng by early May, coinciding with the annual spring maximum of benthic diatoms dominated by Melosira varians and Diatoma vulgare. Size fractionation tests show organisms in the eight mu-m fraction responsible for an anomalously high proportion of total sulfate uptake. Since axenic cultures of the dominant diatom species were not readily available, dark sulfate experiments were conducted with N. pelliculosa, also present in the river. (Lynch-Wisconsin)
W79-09044

CONCEPT OF SPECIES SUCCESSION IN RELATION TO RIVER VEGETATION AND MANAGEMENT,
Freshwater Biological Association, Wareham (England). River Lab.
F. H. Dawson, E. Castellano, and M. Ladle.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, Part 2, p 1429-1434. 2 fig, 2 tab, 12 ref.

Descriptors: *Bere Stream(England), *Water management(Applied), *Stability, *Biological communities, *Rorippa nasturtium-aquaticum, *Ranunculus penicillatus var calcareous, *Succession, Macrophytes, Seasonal, Streams, Rivers, Piddle River basin(England), Dominant organisms, Biomass, Climate, Discharge(Water), Streamflow, Ecosystems, Ecology, Climax, Cycloclimax, Benthic flora, Chalk streams, Life cycles, Flood control, Maturity, Competition.

Annual succession of the codominant macrophyte species Ranunculus penicillatus var. calcareous and Rorippa nasturtium-aquaticum in Bere Stream, a chalk stream in the River Piddle basin, Dorset, England, represents a stable aquatic community which has reached Whittaker's 'cycloclimax'. The submerged Ranunculus typically regrows from rhizomes buried in the streambed during high fall discharge, increasing to maximum biomass and cover by late spring, when, with decreasing water velocity, Rorippa propagules invade, restricting Ranunculus growth except in areas of higher velocity. Fall floods wash out all emergent Rorippa, leaving only the few firmly rooted Ranunculus. Variations in timing of the cycle strongly affect biomass of the plants. The linkage of the two species is a type of homeostatic control ensuring persistence and long-term residence of both species. Biomass and production variations, particularly of Rorippa, are oscillations around a maximum persistent summer biomass, a feature typical of mature communities and ecosystems. In cycloclimax, generations are timed to annual environmental fluctuations. In Bere Stream the normal management regime minimizes flood risk through reduction of plant growth by severe cutting and restricting the Rorippa invasion. Designation of cycloclimax implies that environmental factors can be altered without greatly changing vegetation, though management may change life cycles. Artificial changes in the seasonal discharge pattern would affect the relative temporal dominance of the species. (Lynch-Wisconsin)
W79-09045

OBSERVATIONS ON A SPRING DIATOM BLOOM IN THE RIVER THAMES,
Water Research Association, Marlow (England). T. J. Lack, R. E. Youngman, and R. W. Collingwood.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 2, p 1435-1439, 3 fig, 8 ref.

Descriptors: *Diatoms, *Discharge(Water), *Thames River(England), *Velocity, *Stephanodiscus hantzschii, *Limiting factors, *Eutrophication, Silica, Nitrogen, Phoshorus, Nutrients, Rivers, Chrysophyta, Algae, Phytoplankton, Water temperature, Solar radiation, Light intensity, Chlorophyll, Abundance, Conductivity, Nitrates, Phosphates.

Among several parameters, discharge or water velocity is the most important factor influencing diatom populations during spring phytoplankton bloom along 21 km of the Thames River, England.

between Reading and Hurley Lock. Silica never declined to limiting concentrations during this study in spring 1969, and nitrogen and phosphorus were at high levels (six mg NO3-N/l and 0.44 mg PO4-P/l). Though no consistent differences in conductivity can be detected among the sites, it is generally inversely related with chlorophyll concentration. Solar radiation fluctuates considerably from 29-436 cal/sq cm/day, but no clear relationship can be established with cell number. At all sites water temperature ranges 7.2-15.4 C, with no consistent differences among sites; however average temperature increases from 10.84 C upstream to 12.11 C downstream. Algal populations are composed largely of centric diatoms dominated numerically by Stephanodiscus hantzschii. All sites show close similarity between cell number and chlorophyll concentration, though cells vary in chlorophyll content 110,000-340,000 cells/mu-g. Discharge of the river sweeps away algal cells; critical discharge at Caversham in a previous study was 40 cu m/sec, at which velocity algae are swept away faster than they could divide. At all sites sudden increases in discharge are accompanied by rapid decreases in algal numbers and chlorophyll levels. (Lynch-Wisconsin)
W79-09046

DRIFT OF GAMMARUS PULEX L. IN RELATION TO MACROPHYTE CUTTING IN FOUR SMALL DANISH LOWLAND-STREAMS,
Miljostyrelsen, Silkeborg (Denmark). Freshwater Lab.
U. Kern-Hansen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1440-1445. 2 fig, 2 tab, 11 ref.

Descriptors: *Gammarus pulex, *Streams, *Aquatic weed control, *Mechanical control, *Amphipoda, *Environmental effects, Habitats, Macrophytes, Denmark, Invertebrates, Currents(Water), Limiting factors, Gransleeve Stream(Denmark), Lyngbyfard Stream(Denmark), Gjern Stream(Denmark), Fjederholt Stream(Denmark), Streamflow, Marginal vegetation.

Total cutting of macrophytes in four Danish lowland streams resulted in a great increase in drift density of the amphipod Gammarus pulex due to removal of the invertebrate's shelter from the current. Macrophytes provide shelter for a variety of invertebrates and fish. Partial cutting, leaving 50% of the macrophyte biomass in bars across the stream, did not significantly increase drift density, while leaving 35% of the biomass as narrow bars along stream margins resulted in a small increase in drift density. Sites with dense strands of macrophytes are also known to act as natural sieves, reducing the total distance travelled by drifting G. pulex. Upstream movements of G. pulex occurring especially in areas of slower current are normally sufficient to compensate for drift, but complete macrophyte removal reduces such areas of slower current and thus the possibilities for compensation. Leaving a narrow margin of plants helps to alleviate this situation. It is recommended that in programs of mechanical plant control a portion of the plants be left as transverse bars and another portion as narrow marginal stands. Experiments were conducted during the summers of 1974-76 in Granslev, Gjern, Lyngbygard, and Fjederholt Stream, the first dominated by Elodea canadensis, and Potamogeton crispus, the second and third by Spearganium simplex, and the last by Ranunculus peltatus. Streams are 80-90% covered by the plants, were unshaded, and have biomass in the range 200-350 g/sq m dry wt. (Lynch-Wisconsin)
W79-09047

RIVER GUDENA INVESTIGATION, 1973-1975,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
P. B. Heise, N. Nyholm, and J. F. Simonsen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1446-1450. 5 fig, 1 tab, 3 ref.

Descriptors: *Gudena River Basin(Denmark), *Water pollution control, *Sewage disposal, *Agricultural runoff, *Industrial wastes, *Water pollution sources, Urban runoff, Sewage treatment, Biological treatment, Biochemical oxygen demand, Lake Tange(Denmark), Denmark, Rivers, River basins, Nutrient loading, Nutrients, Phosphorus, Transparency, Phytoplankton, Algae, Mathematical models, Model studies, Dissolved oxygen, Primary productivity, Streamflow, Recreation.

A water quality study 1973-75 of the Gudena River Basin, Denmark, showed worst pollution in a tributary, Hadsten Lillea, which receives untreated sewage from the town of Hadsten (pop. 30,000) at a flow rate of 300 1/sec. A mathematical model simulating oxygen fluctuations indicates need for a biological treatment plant capable of limiting effluent BOD5 to 20 mg/l, ensuring that oxygen concentrations would not drop below two mg/l for more than four hrs anywhere in the river. In the basin as a whole, oxygen concentrations are satisfactory. The 145-km Gudena River, the longest in Denmark, drains an area of 2700 sq km known as the Danish Lake District, used for intensive recreation. Annually about 8000 tons COD, 4100 tons nitrogen, and 300 tons phosphorus are discharged to receiving waters. Domestic and industrial sewage account for some 20% of total nitrogen and 75% of total phosphorus loadings, and trout farms about 4% of nitrogen and 8% of phosphorus. Data on daily agricultural runoff show high correlation between water flow and nitrogen flux, but not with phosphorus because of a relatively high concentration of phosphorus in farm-discharged sewage. Background phosphorus levels are generally high, about 0.06 mg P/l. About 30% of annual nitrogen and 35% of annual phosphorus loadings are retained in lakes and watercourses due to sedimentation. The LAVSOE model was employed to predict effects of nutrient input control on phytoplankton and transparency in Lake Tange. (Lynch-Wisconsin)
W79-09048

AQUATIC WEED MANAGEMENT IN NATURAL STREAMS: THE EFFECT OF SHADE BY THE MARGINAL VEGETATION,
Miljostyrelsen, Silkeborg (Denmark). Freshwater Lab.
F. H. Dawson, and U. Kern-Hansen.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978, part 2, p 1451-1456. 4 fig, 2 tab, 8 ref.

Descriptors: *Marginal vegetation, *Shading, *Streams, *Aquatic weed control, *Vegetation establishment, Denmark, England, Water management(Applied), Flood control, Drainage, Bere Stream(England), Esrom Stream(Denmark), Granslev Stream(Denmark), Gjern Stream(Denmark), Fjederholt Stream(Denmark), Macrophytes, Environmental control, Habitats, Ranunculus, Elodea canadensis, Sparganium simplex, Rorippa nasturtium-aquaticum, Limiting factors, Depth, Light intensity.

Establishment of stream bank vegetation for shading is a good ecological alternative to mechanical cutting of aquatic weeds for land drainage and flood control purposes, based on experiments at Danish and English stream sites. Bushes or trees on the south bank of a stream will reduce light available at the stream surface by about two-thirds, resulting in a reduction in aquatic plant biomass by 70-90%; on the north bank vegetation may reduce plant biomass by about 50%. If a tree line is established on the south bank, 20-m gaps should be left every 70 m to allow growth of plants in bars across the stream to provide invertebrate habitats, fish cover, and traps for leaf litter. Shading reduces extreme and rapid development of macrophytes, spreads out their production, increases species diversity, and extends organic matter availability over a greater number of months. Intensive management through cutting and dredging restricts habitat diversity and encourages excessively even distribution and composition of biota and sediments. Experimental sites include Fjederholt, Granslev, Esrom, and Gjern Streams in Denmark, and Bere Stream in Dorset, England, subject to removal of various macrophytes, especially Ranunculus spp., Elodea canadensis, Sparganium simplex, and Rorippa nasturtium-aquaticum. To supplement the studies of vegetative shading, five 18-m stream sections of Fjederholt Stream were shaded with mesh, cloth, and plastic; plant regrowth is almost directly proportional to the light reaching the water surface, though water depth is also important. (Lynch-Wisconsin)
W79-09049

RESPONSE OF PHYTOPLANKTON TO WATER QUALITY IN THE CHOWAN RIVER SYSTEM,
North Carolina State Univ. at Raleigh. Dept. of Botany.
A. M. Witherspoon, C. Balducci, O. C. Boody, and J. Overton.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 007, Price codes: A10 in paper copy, A01 in microfiche. Water Resources Research Institute, University of North Carolina, Raleigh. Rpt. No. 129, April 1979. 204 p, 124 fig, 7 tab. OWRT B-091-NC(2), 14-34-0001-6104.

Descriptors: *Phytoplankton, *Algae, Algal growth, Algal blooms, Nitrogen, Organic phosphorus, Chowan River(NC).

Seasonal changes in phytoplankton species diversity and biomass, phosphorus uptake kinetics, in-situ and in-vitro algal growth potential and phytoplankton-bacteria interaction in the Chowan River system were investigated from March 1974-June 1977. The river is divided into two sections with respect to phytoplankton dominants: (1) the upper, faster-flowing narrow section from its beginning at the confluence of the Nottoway and Blackwater Rivers to the bend in the river some 16 km downstream; and (2) the lower, wider section with very low water flow that extends approximately 64 km from the deep bend in the river to its mouth near Edenton, NC. The upper river is characterized by seasonal changes in dominants, usually of the flagellated types. Diatoms are omnipresent with fewer blue-green, green, and yellow-green algal types appearing seasonally. The lower river is characterized by filamentous blue-green algae during spring and summer. The slower-moving water in this section promotes longer residence time for nutrients and algae; therefore, it is plagued with seasonal algae blooms. There are five species that may become dominant during the blooms: (1) Anabaena circinalis, (2) Anabaena aegualis, (3) Anabaena wisconsinense, (4) Anacystis (Microcystis) firma, and (5) Aphanizomenon flosaquae (gracile). The blooms are inversely correlated with nitrate and phosphate concentrations in the river. However, substantial levels of biomass are able to persist after PO4, NO3, and NH3 concentrations are below detectable levels. In its present status, Chowan River water quality, without point-source input, is sensitive to the hyrographical and hydrophysical condition of the river. Sound management practices, therefore, must concentrate on the controllable conditions that potentially could further decrease water quality. (Kiger-North Carolina)
W79-09056

IMPROVING WATER QUALITY BY CONTROL OF ALGAE: BIOCHEMICAL CHARACTERIZATION OF THE POLYSACCHARIDES OF BLUE-GREEN ALGAE AND THEIR ROLE IN BACTERIAL-ALGAL,
Iowa State Univ., Ames. Dept. of Botany and Plant Pathology.
R. B. Wildman, W. C. Wildman, G. E. Rottinghaus, and V. P. Cholvin.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 149, Price codes: A07 in paper copy, A01 in microfiche. Iowa State Water Resources Research Institute, Iowa State University, Report No. ISWRRI-94. Completion Report, April 1979. 127 p, 14 fig, 18 tab, 141 ref. OWRT B-059-IA(1). 14-34-0001-7119.

Descriptors: *Eutrophication, *Cyanophyta, *Aquatic bacteria, Aquatic life, Anabaena, Aquatic algae, Algae, Water pollution sources, Water qual-

ity control, Carbohydrates, Carbon, Lakes, Effluents, Industrial crops.

The relationship between a model bloom species, Anabaena spiroides, and the bacteria naturally associated with the mucilaginous algal sheath were studied. The structural properties and biochemical composition of the algal extracellular polysaccharide were examined comprehensively. During algal blooms, the dissolved carbohydrate in lake water was isolated and hydrolyzed, and the monosaccharide composition was determined. Isolates of sheath bacteria were cultured, nutritional requirements were determined, and the bacteria's ability to utilize algal polysaccharides and/or component monosaccharides was established. Extracellular polysaccharides were shown to be a major contributor to the dissolved carbohydrate found in natural waters. The extracellular polysaccharide of Anabaena spiroides was shown to be a large and complex molecule with linked xylose-glucose and fucose-arabinose units; branching sugars are linked rhamnose-fucose and glucose residues. The model bloom is a likely candidate for industrial applications due to its properties of high viscosity and pseudo-plasticity, and stability to ranges of temperature, pH, and salt concentration. High levels of dissolved organic matter are a preferred carbon source for aquatic bacteria, therefore a necessary deterrent to massive algal blooms may be removal or reduction of biodegradable organic matter from effluents entering aquatic systems. (Schaefer-IPA)
W79-09060

SURFACE WATER QUALITY PARAMETERS FOR MONITORING OIL SHALE DEVELOPMENT,
Environmental Monitoring and Support Lab., Las Vegas, NV.
W. L. Kinney, A. N. Brecheisen, and V. W. Lambou.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-297 984, Price codes: A08 in paper copy, A01 in microfiche. Report No. EPA-600/4-79-018, March 1979. 153 p, 8 fig, 52 tab, 65 ref, 1 append.

Descriptors: *Oil shales, *Water quality, *Water pollution, *Environmental effects, *Environmental impact, *Colorado River Basin, Surface waters, Energy conversion, Pollution monitoring, Water resources, Waste water(Pollution), Salinity, Biological communities, Hydrography, Industrial water, Microorganisms.

The potential environmental impact of oil shale development and the parameters needed for assessing and monitoring the impact on surface water resources are reported. Data are given for the proposed development of an oil shale industry on the western slope of the Rocky Mountains and the impact of the water resources of the Colorado River Basin. Potential impact areas discussed include: salinity, toxic substances, nutrients, hydrographic modification, microorganisms, radioactivity, oil and grease, temperature, sediments, dissolved oxygen, pH, and carbon dioxide. A prioritized list of chemical, physical, and biological parameters for monitoring surface waters potentially impacted is presented. Monitoring parameters include those substances which in themselves are potential pollutants and are measurable directly, as well as those indicator parameters whose measurements provide an indirect measure of pollution or are required for the interpretation of other water quality data. One of the major potential impacts reported was an increase in salinity. It was concluded that the establishment of a commercial oil shale industry in the studied area would pose a threat to the water resources of the Colorado River Basin, both on a regional and local scale. (Seigler-IPA)
W79-09069

STREAM MODELS FOR CALCULATING POLLUTIONAL EFFECTS OF STORMWATER RUNOFF,
Municipal Environmental Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 7C.
W79-09076

RESPONSE OF A SALT MARSH TO OIL SPILL AND CLEANUP: BIOTIC AND EROSIONAL EFFECTS IN THE HACKENSACK MEADOWLANDS, NEW JERSEY,
URS Co., San Mateo, CA.
P. C. Dibner.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-285 211, Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA-600/7-78-109, June 1978. Prepared for the U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnati, Ohio. 61 p, 16 fig, 7 tab, 22 ref, 1 append. 68-03-2160.

Descriptors: *Salt marshes, *Oil spills, *Bank erosion, Estuarine environment, Rivers, Grasses, Marsh plants, Marshes, Water pollution effects, Oil pollution, Water pollution, Cutting management, Tidal marshes.

The biological and erosional response of portions of the Hackensack Meadowlands estuarine marsh to a two million gallon spill of number 6 crude oil in May 1976, and to the subsequent cleanup operations were examined. Contaminated vegetation which continued to release oil to the waters was cut and removed; these included the gross Spartina alterniflora. Damage to Spartina was primarily due to the physical, not chemical (toxic) properties of the oil. Heavily oiled Spartina that were neither washed clean by tides not cut had the highest mortality. Cutting plants as a technique for reducing long-term damage to them must, to be successful, take into account a combination of factors including the biology of the contaminated species, the elapsed time between contamination and cutting, the season in which cutting is performed, and the characteristics of the oil. For Spartina, cutting soon after contamination was beneficial and apparently reduced long-term damage despite the fact that it entailed trampling the grasses. This foot traffic may have contributed to severe bank erosion by making the river bank more susceptible to erosion by boat wakes and natural wave and current action. (Schaefer-IPA)
W79-09077

5D. Waste Treatment Processes

INSTITUTIONAL BARRIERS TO WASTEWATER REUSE.
California Univ., Los Angeles. Office of Environmental Science and Engineering.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 027, Price codes: A15 in paper copy, A01 in microfiche. Office of Water Research and Technology, Report OWRT/RU-79/4, (1979). 327 p, 86 fig, 3 append. OWRT R-0064(7814)(1). 14-34-0001-7814.

Descriptors: *Water reuse, Cost analysis, Decision making, *Governmental interrelations, Impaired water quality, Legal aspects, Political constraints, *Institutional constraints, Public health, *Reclaimed water, Recycling, Waste water disposal.

This study addresses institutional barriers to enhanced reuse of wastewater as a supplement or replacement for added freshwater supply. The primary vehicle has been three case studies of reclamation activities in southern California. Facilities used as examples are the San Jose Creek, Pomona and Water Factory 21 reclamation plants. Four areas of critical institutional concern are analyzed: (1) issues related to the administrative and institutional framework within which operations must be managed, (2) the legal framework which applies to reuse, (3) the economics, financing and pricing of reclaimed wastewater, and (4) issues growing from the risk to public health of reuse of treated wastewater. Conclusions as to issues of major importance are presented and recommendations drawn which could enhance wastewater reuse potential. The most important issues relate to health risk and its proper assessment. Others relate to the efficient, integrated planning and management of all water supplies. Proper cost comparisons between alternatives, consideration of external costs, and financing also constitute an important issue area. Legal requirements and the level of government best suited to manage also are considered. General conclusions as to further research needs are presented.
W79-09050

5E. Ultimate Disposal Of Wastes

INSTITUTIONAL BARRIERS TO WASTEWATER REUSE.
California Univ., Los Angeles. Office of Environmental Science and Engineering.
For primary bibliographic entry see Field 5D.
W79-09050

ASSESSMENT OF LAND TREATMENT TECHNOLOGY FOR TEXTILE MILL INDUSTRY,
North Carolina State Univ. at Raleigh. Dept. of Biological and Agricultural Engineering.
D. Pal, and M. R. Overcash.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 030, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Institute, University of North Carolina, Raleigh. Rpt. No. 140, June 1979. 33 p, 7 fig, 16 tab. OWRT B-100-NC(8), 14-34-0001-7173.

Descriptors: *Land treatment, Industrial wastes, *Textile mill industry, Textile mills, Land application, Dyes, Textile waste treatment.

The textile mill industry consisting of six subcategories of manufacturing must continually review the options for meeting state and federal environmental regulations. Land treatment is becoming a method of choice for an increasing number of mills. This report examines land treatment on a first-cut basis. Average plant sizes for each six subcategories are used along with representative waste and soil characteristics. These results do not represent design criteria because of the highly critical need to test the waste and site to be used, before specifying or permitting of such systems. Instead the results of this report should be used to compare the land treatment alternative of conventional processes. Although not included specifically, land treatment can meet the highest levels of waste treatment (RCRA, BAT, etc) when correctly designed, thus comparison against other alternatives should include the advanced wastewater treatment requirements for meeting present and future regulations. In addition to the evaluation of land treatment as an option for the textile mill industry, a fundamental design procedure is presented for land treatment design. This procedure demonstrates the detailed levels of soil and waste analyses required to design any land application system. Successful long term performance and adherence to soil, food-chain, groundwater nondegradation constraints depend on utilizing an in-depth design procedure. Results of this study have demonstrated the difference attributable to soils, the waste parameters which are critical in design, the potential savings associated with in-plant source control. (Kiger-North Carolina)
W79-09055

5G. Water Quality Control

NUTRIENT KINETICS OF PHYTOPLANKTON IN THE PAMLICO RIVER, NORTH CAROLINA,
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 2L.
W79-09057

WATER QUALITY MANAGEMENT MODEL FOR THE LOWER CHOWAN RIVER,
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W79-09058

PROTECTION, CLEANUP AND RESTORATION OF SALT MARSHES ENDANGERED BY OIL SPILLS: A PROCEDURAL MANUAL,

URS Co., San Mateo, CA.
D. J. Maiero, R. W. Castle, and O. L. Crain.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-291 958, Price codes: A08 in paper copy, A01 in microfiche. Report No. EPA-600/7-78-220, November 1978. Prepared for the U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Cincinnati, Ohio. 164 p, 26 fig, 14 tab, 5 append. 68-03-2160.

Descriptors: *Salt marshes, *Oil spills, *Water pollution control, Marshes, Tidal marshes, Oil pollution, Water pollution effects, Water pollution sources, Publications, Coastal marshes, Water pollution treatment, Oily water.

Information and guidelines on the best application of protection, cleanup, and recovery activities from oil spills in order to minimize the damage to marshlands and to speed their recovery are provided. A step-by-step approach to protective, cleanup, restoration, and waste handling measures is given. The user's basic knowledge of oil spill characteristics and attendant technologies as well as a basic understanding of the coastal environment is assumed. Classification schemes for oil and marsh are discussed. Protective measures are detailed including: field observations; spill size and movement prediction; general protection priorities; protective devices and techniques, their selection and impact; and termination of the measures. As with the protective phase, a gathering of general information, knowledge of the characteristics of the spilled oil, identification of the sensitivity and unique features of the endangered marshland, and an investigation of any threat against public and personnel safety is necessary in the cleanup phase. Natural cleaning, recontamination potential, cleanup techniques, their selection and impact access/trafficability, general priorities, and degree of cleanup are detailed. Natural recovery versus the need for restoration, restoration techniques, monitoring of restoration, and methods of waste handling are discussed. (Schaefer-IPA)
W79-09073

ACHIEVING IRRIGATION RETURN FLOW QUALITY CONTROL THROUGH IMPROVED LEGAL SYSTEMS,
Resources Administration and Development, Inc., Fort Collins, CO.
G. E. Radosevich, and G. V. Skogerboe.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-295 653, Price codes: A14 in paper copy, A01 in microfiche. Report No. EPA-600/2-78-184, December 1978. Prepared for the U.S. Environmental Protection Agency, Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma. 311 p, 55 fig, 4 tab, 64 ref, 3 append. R-804303.

Descriptors: *Return flow, *Water quality control, *Legal aspects, Water law, Water rights, Administrative agencies, Irrigation water, Water pollution sources, Water reuse, Water pollution control, Water quality standards, Regulation, Agricultural chemicals, Legislation.

An examination of the water quality control laws of the western states and of the extent to which the two legal systems (quantity and quality control) interface are presented. The integration of legal controls with physical/technical realities is explored. Irrigation return flows contribute to the problem of deteriorated water quality through use of water, land, and agricultural chemicals. Return flows occur from seepage losses, deep percolation, and tailwater runoff; pollutants include salinity, nitrates and phosphates (or nutrients), sediments, biocides, and bacteria. Three recommendations are made for Federal and State activities to achieve quality control for irrigation return flow: an action program, called the Influent Control Approach; a course of action to implement the program; and an identification of research needs. The program requests the states to: (1) designate areas and responsible entities for irrigation return flow quality management; (2) develop standards and criteria; (3) introduce incentives for efficient water use; (4) include water quality in water rights; (5) adopt and enforce a reporting and recording system for water rights; (6) recognize reasonable degradation from agricultural water use; (7) adopt an Agriculture Practice Act; and (8) promote cooperation of state water agencies. (Schaefer-IPA)
W79-09079

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

QUANTITATIVE SITUATIONAL ANALYSIS, A PLANNING TOOL FOR WATER RESOURCE MANAGERS.
Purdue Univ., Lafayette, IN. Water Resources Research Center.
H. Johnston Nicholson, and C. H. Castore.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 116, Price codes: A09 in paper copy, A01 in microfiche. Technical Report No. 120, March 1979. 191 p, 8 fig, 56 tab, 88 ref, 14 append. OWRT C-7005 (no. 6202)(9).

Descriptors: *Water resources planning, *Cost benefits, Risks, Nuclear power plants, Potable water, Herbicides, D 2-4 herbicide, T 2-4-5 herbicide, Defoliants, Decision making, Public participation, Power plant siting.

A planning methodology is developed which provides for the water resource managers and decision makers a procedure for structuring and quantifying public input into water resources management decisions. The method referred to as Quantitative Situational Analysis provides an opportunity to assess and predict the response of public officials, intensely interested groups, and the general public to a technology innovation which may be of a controversial nature. The procedure is especially adapted to those decisions involving low risk - high consequence technology. The report discusses the theoretical basis for the method and then develops three case studies involving low risk-high consequence technologies. One is the siting of a nuclear power plant, using the Bailly plant, to be located on Lake Michigan. Another is the implementation of the Safe Drinking Water Act and the public's perception of its importance and adequacy. The third is the local people's reaction to the U.S. Air Force's decisions to dispose of 2.3 million gallons of herbicide 'Orange' on some Federal land in Utah. Results of each of these case studies are presented. (Wiersma-Indiana)
W79-09051

AQUIFER MODELING BY NUMERICAL METHODS APPLIED TO AN ARIZONA GROUNDWATER BASIN,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
G. E. Fogg, E. S. Simpson, and S. P. Neuman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-298 962, Price codes: A08 in paper copy, A01 in microfiche. Technical Report 32, June 1979. 140 p, 34 fig, 9 tab, 46 ref. OWRT C-7515(no. 6235)(1), 14-34-0001-6235.

Descriptors: *Model studies, Arizona, Groundwater, Computer models, Groundwater recharge, *Aquifer modeling.

FLUMP, a recently developed mixed explicit-implicit finite-element program, was calibrated against a data base obtained from a portion of the Tucson Basin aquifer, Arizona, and represents its first application to a real-world problem. Boundary conditions used in the calibration of FLUMP were prescribed hydraulic heads obtained from direct measurement. At prescribed head boundaries FLUMP computed time-varying fluxes representing subsurface lateral flow and recharge along streams. FLUMP correctly calculated fluctuations in recharge along the Santa Cruz River due to fluctuations in storm runoff and sewage effluent rates and provided additional distributions of recharge, discharge, and subsurface flow in the study area. Properties of FLUMP were compared with those of ISOQUAD, a finite-element program developed by Pinder and Frind, and a finite-difference program developed by the U.S. Geological Survey. It appears that FLUMP can handle a larger class of problems than the other two programs, including those in which the boundary conditions and aquifer parameters vary arbitrarily with time and/or head. FLUMP also has the ability to solve explicitly when accuracy requires small time steps, the ability to solve explicitly in certain parts of the flow region while solving implicitly in other parts, flexibility in mesh design and numbering of nodes, computation of internal as well as external fluxes, and global as well as local mass balance checks at each time step.
W79-09052

A MATHEMATICAL HYDRODYNAMIC CIRCULATION MODEL OF GREAT SALT LAKE FOR RESOURCE MANAGEMENT,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 2H.
W79-09054

WATER QUALITY MANAGEMENT MODEL FOR THE LOWER CHOWAN RIVER,
North Carolina State Univ. at Raleigh. Dept. of Civil Engineering.
M. Amein, and W. S. Galler.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-299 188, Price codes: A08 in paper copy, A01 in microfiche. Water Resources Research Institute of The University of North Carolina, Raleigh. UNC-WRRI Rpt. No. 130, April 1979. 159 p, 42 fig, 8 tab. OWRT B-081-NC(2), 14-34-0001-5099.

Descriptors: *Mathematical models, Stream forecasting, Algal biomass, Nitrogen uptake, *Chowan River(NC).

A mathematical numerical model for the Lower Chowan River was developed to predict water quality under the influence of changing flow, temperature, tide, and wind conditions, and inputs of wastes and nutrients and to predict the effectiveness of control measures for water quality management. This model was developed for the Chowan, but is actually a general river and estuary model which can be applied to any waterway which can be treated as a one-dimensional flow channel. The application is entirely controlled by means of input data. The model consists of two parts: (a) a flow dynamics module, and (b) a water quality module. The flow dynamics module is based on the finite difference representation of the equations for the conversion of mass and momentum of water flow in estuaries. The water quality module is based on the finite difference representation of the diffusion equation. There is great variability in the field data, and the model was calibrated to predict the average conditions. Detailed analyses of the estuarine processes are needed to determine critical values for nutrient concentrations and optimum conditions of light, temperature, and water flow for blooms. (Kiger-North Carolina)
W79-09058

6B. Evaluation Process

ENERGY FROM THE WEST: ENERGY RESOURCE DEVELOPMENT SYSTEMS REPORT, VOLUME VI: GEOTHERMAL,
Oklahoma Univ., Norman. Science and Public Policy Program.
I. L. White, M. A. Chartock, R. L. Leonard, S. C. Ballard, and M. Gilliland.
Report No. EPA-600-7-79-060f, March 1979. Prepared for U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. 217 p, 12 fig, 61 tab, 18 ref. 68-01-1916.

Descriptors: *Geothermal studies, *Energy conversion, *Environmental effects, *Hydrothermal studies, Exploration, Drilling, Thermal power, Steam, Water vapor, Cost analysis, Water pollution, Air pollution, Arizona, Colorado, Montana, New Mexico, North Dakota, South Dakota, Utah, Wyoming.

The technologies, inputs, outputs, rules, and regulations associated with the development of geothermal energy resources in eight western states are described. A general description of the geothermal energy resources is provided along with the steps or activities involved in developing each. Geology, location, quantity, physical and chemical characteristics, and property ownership are among areas covered. Activities involved in the development of geothermal energy resources include: exploration, extraction (both drilling and production phases), and electricity generation or non-electric utilizations. For each activity, technological alternatives are discussed which represent potential development options. Input requirements and output for each activity or alternative are presented where possible. Input requirements include: manpower, materials and equipment, economics, water, land, and ancillary energy. Outputs, the residuals from each activity or alternative that may pose environment hazards, include: air emissions, water effluents, solid wastes, noise pollution, occupational health and safety hazards, and odor. Laws and regulations governing the development of geothermal resources are also discussed. (Seigler-IPA)
W79-09066

6E. Water Law and Institutions

TODAY IS YESTERDAY'S TOMORROW,
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 6G.
W79-08832

6G. Ecologic Impact Of Water Development

TODAY IS YESTERDAY'S TOMORROW,
Canada Centre for Inland Waters, Burlington (Ontario).
J. R. Vallentyne.
In: Proceedings: 20th Congress, Internationale Vereinigung fur Theoretische und Angewandte Limnologie; Copenhagen, Denmark, 8 August 1977. Vol. 20, September 1978. Part 1, p 1-12, 9 tab, 10 ref.

Descriptors: *Energy conservation, *Demophoric index, *Resource management, *International cooperation, *Environmental carrying capacity, *Theoretical analysis, Conservation, Energy, Metabolism, Technology, Water pollution control, Limnology, Runoff, Ecology, Ecosystems, Demography, Population.

The concepts of environmental carrying capacity and demographic (D) index are discussed, the current status of energy consumption among world nations is assessed, and a resolution relating to global resource consumption (especially as it pertains to water resources) is proposed for approval at the 20th Congress of the Internationale Vereinigung fur Theoretische und Angewandte Limnologie in Copenhagen, Denmark (8 August 1977). 'Demophoric' refers to the unusual status of man's mass and metabolism, which combines both internal (biological) and external (technological) components, not explicitly recognized in ecological terms until the 1970s. Tables are presented which relate population (P), technological population or energy slaves (T), demophoric units (P+T), and demophoric index (T/P), the ratio of technological to biological metabolism, for various countries of the world. One D-unit=829,000 kcal/yr. Average global D-index is 16, ranging from < 1 in several African countries to 97 in the United States, which also has the highest number of D-units (20.4 billion). Since the earth's demophoric carrying capacity is rapidly being approached, or has already been exceeded, it is imperative that worldwide control measures be taken. A 70-year lead time is proposed for achieving an orderly political progression to an eventual state of zero demophoric growth. (Lynch-Wisconsin)
W79-08832

EUTROPHICATION MODEL FOR THE MIDDLE REACHES OF THE LOIRE (MODELE D'EUTROPHISATION DE LA LOIRE MOYENNE),
Echauffement et Pollution des Eaux, Ecologie Div., Chatou (France).
For primary bibliographic entry see Field 5C.
W79-08990

7. RESOURCES DATA

7A. Network Design

AN IMPROVED OXYGEN METHOD FOR MEASURING PRIMARY PRODUCTION IN LAKES,
Bern Univ. (Switzerland). Zoologisches Inst.
For primary bibliographic entry see Field 5C.
W79-08835

7B. Data Acquisition

REMOTE SENSING,
General Electric Image Processing Lab., Beltsville, MD.
C. Croteau.
Water Spectrum, Vol. 11, No. 3, p 46-53, Summer 1979. 6 fig, 1 tab.

Descriptors: *Remote sensing, *Water resources development, Exploration, Mapping, Landsat, Satellites(Artificial), Planning, Photography, Photogrammetry, Analytical techniques.

The present state of remote sensing is examined, and future use is projected. Remotely sensed parameters have been used as input for studies related to water resources systems planning, design, and management. Remote sensing is a vital part of ice and snow mapping. Liquid and solid forms of water can be detected and measured by remote sensing; the trained observer reads indirect signs, as well as those directly observable, that indicate water. It is difficult to remotely assess water quality, but there is significant value in the ability to observe turbidity. Remote sensing systems generally consist of four components: the platform (usually an airplane or satellite), the sensor, communications equipment to transmit the sensor signal, and processing equipment, which converts the transmission to understandable data. A trend toward computerized, non-photographic sensing systems is accelerating due to the availability of digitized data, the rapidly declining costs of computer hardware, and the performance advantages of the medium. Systems designed to detect change require registration, or overlay of data taken at different times and a data base keyed to geography. Improved resolution, timeliness, data compatability, and more frequent coverage are expected in future systems. (Schaefer-IPA)
W79-09063

RATES, CONSTANTS, AND KINETICS FORMULATIONS IN SURFACE WATER QUALITY MODELING,
Tetra Tech, Inc., Lafayette, CA.
S. W. Zison, W. B. Mills, D. Deimer, and C. W. Chen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-290 938, Price codes: A15 in paper copy, A01 in microfiche. Report No. EPA-600/3-78-105, December 1978. Prepared for the U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia. 335 p, 30 fig, 72 tab, 358 ref. R804450-01-2.

Descriptors: *Surface waters, *Water quality, *Model studies, Analytical techniques, Mathematical models, Structural models, Reaeration, Dissolved oxygen, Nitrification, Oxygen demand, Phytoplankton, Algae, Zooplankton, Coliforms, Measurement, Hydrodynamics, Chemistry, Biology.

A set of formulations and associated constants in the field of water quality modeling is presented as comprehensively as possible. A process-oriented literature review of rate parameters used in surface water quality models includes information of model conceptualization, and physical, biological, and chemical processes. Geometric representations, temporal variations, and hydrodynamic considerations are discussed in relation to model conceptualization. Advective and dispersive transport, heat budgets, ice formation, and light attenuation were the physical processes reviewed. Biological processes reviewed included dish, detritus, benthic organisms, and sediment deposits; chemical processes reviewed included the nitrogen, phosphorus, and silicate cycles, dissolved oxygen, toxic materials, the carbonate system, and conservative substances. A very detailed discussion of selected parameters and formulations is presented on issues that are ordinarily of primary interest in modeling studies: reaeration, dissolved oxygen saturation, photosynthesis (without modeling phytoplankton), biochemical and benthic oxygen demands, nitrification, coliform bacteria, phytoplankton, and zooplankton. (Schaefer-IPA)
W79-09078

7C. Evaluation, Processing and Publication

STREAM MODELS FOR CALCULATING POLLUTIONAL EFFECTS OF STORMWATER RUNOFF,
Municipal Environmental Research Lab., Cincinnati, OH.
R. Smith, and R. G. Eilers.
Available from the National Technical Information Service, Springfield, VA 22161 as PB-286 930, Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA-600/2-78-148, August 1978. 107 p, 18 fig, 16 tab, 20 ref, 3 append.

Descriptors: *Storm runoff, *Water pollution effects, *Mathematical models, Overflow, Dissolved oxygen, Storm water, Streams, Data processing, Computer programs, Water pollution, Hydraulic models, Equations, Rivers, Biochemical oxygen demand.

Three related studies for developing better methods for quantifying the pollutional effects in streams caused by stormwater overflows are described. Mathematical models developed simulate the biological, physical, chemical, and hydraulic reactions that occur in a flowing stream. The relationships are presented as differential or difference equations with the two independent variables: time and distance along the stream. Analog or digital computers, or calculus can be used to find solutions to the differential equations. This solution is the concentration of all species of pollutional interest within the stream as a function of time and distance. There are two regimes of solutions--steady-state and transient; the pollution loads on a stream can also be specified as steady-state or transient. Two digital computer programs were developed: one computes the dissolved oxygen (DO) deficit in a stream as a function of time and distance along the stream caused by any specified overflow; the second computes the hydraulic effect on the stream of large volume overflows. A method for summarizing the results of computations in an easily used manner was also developed. Because of advanced technology, it is now possible to estimate the impact of any stormwater overflow on the dissolved oxygen resources of a stream by hand computation. (Schaefer-IPA)
W79-09076

8. ENGINEERING WORKS

8A. Structures

HELSINKI METROPOLITAN AREA WATER SUPPLY AND WATER QUALITY IN LAKE PAIJANNE,
Hydrobiological Research Inst., Jyvaskyla (Finland).
For primary bibliographic entry see Field 5C.
W79-08964

LOOK BACK AT THE FUTURE,

N. Clapp, and A. H. Garner.
Water Spectrum, Vol. 11, No. 3, p 20-26, Summer 1979. 8 fig.

Descriptors: *Hydroelectric plants, *Dams, *Rehabilitation, Electric powerplants, Hydroelectric power, Electric power production, Water utilization, Dam construction, Comparative costs, Electric power rates, Power marketing.

The history of hydroelectric power and the undeveloped potential of existing dams are examined. Today's major marketers of hydroelectric power are the Tennessee Valley Authority (TVA), the Department of Energy, and the Power Authority of the State of New York. Over 220 billion kilowatt hours were generated and almost 69 million kilowatts of power were provided in 1977. Big dams provided a lower per-unit cost than smaller sites and smaller stations were allowed to fall into a state of disrepair. The increase in the cost of constructing large-scale generating capacities, and the enormous increase in the cost of fuel oil for intermediate or peak-load generation have prompted a new look at old dams. A great number of small, unused dams exist throughout the country, and there is a comparative absence of environmental problems in making use of already existing dams and reservoirs. Plans have been made for the small plant at Paterson, New Jersey, which closed in 1971, to be restored. During 1981, the first year of operation, value is projected at 2.98 cents per kilowatt-hours; comparing this to production costs, revenues will exceed costs. Costs for rehabilitating small dams are expected to run $1,000 to $2,000 per kilowatt of capacity. As much as $54,600 megawatts of undeveloped capacity exists at such structures. (Schaefer-IPA)
W79-09061

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CENTERS OF COMPETENCE AND THEIR SUBJECT COVERAGE

- Ground and surface water hydrology at the Illinois State Water Survey.

- Metropolitan water resources planning and management at the Center for Urban and Regional Studies of University of North Carolina.

- Eastern United States water law at the College of Law of the University of Florida.

- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.

- Water resources economics at the Water Resources Center of the University of Wisconsin.

- Eutrophication at the Water Resources Center of the University of Wisconsin.

- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

- Water well construction technology at the National Water Well Association.

- Water-related aspects of nuclear radiation and safety at the Oak Ridge National Laboratory.

- Water resource aspects of the pulp and paper industry at the Institute of Paper Chemistry.

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- Effect on water quality of irrigation return flows at the Department of Agricultural Engineering of Colorado State University.

- Agricultural livestock waste at East Central State College, Oklahoma.

- Municipal wastewater treatment technology at the Franklin Institute Research Laboratories.

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